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Editor's Corner

All EOS AM-1, LIS, and SeaWinds teams developed Algorithm Theoretical Basis Documents (ATBDs) in August. The ATBDs were recently reviewed by peer review panels in November and December 1996. These documents, developed for each data product, consist of a detailed physical and mathematical description of the algorithm, variance or uncertainty estimates, and practical considerations, such as calibration and validation, exception handling, quality control, and diagnostics. Once these teams receive their panel reports they will revise their ATBDs according to recommendations of the panels, together with written reviews received from anonymous reviewers to whom the documents were sent prior to the panel meeting. These revised ATBDs will then be posted on the World Wide Web, replacing the 1994 documents that currently reside there.

The first round of ATBD reviews will be conducted March 11-13 for ACRIM, AIRS/AMSU/HSB, AMSR, Data Assimilation, and SAGE III. These teams delivered their ATBDs to the Project Science Office in November. This process is extraordinarily valuable to the science teams and engages the larger scientific community, both nationally and internationally, in the process of providing feedback on approaches to routine data reduction from EOS sensors.

An Investigators Working Group (IWG) meeting is now scheduled for February 25-27 in San Diego, California. As in the past couple of years, the primary focus of this meeting is to: (i) learn of recent progress and exciting accomplishments obtained thus far by various EOS

investigations, including seasonal and interannual climate-related events, global productivity and the carbon cycle, and chemistry-aerosol-climate processes, (ii) assess progress and expectations for EOSDIS in the next couple of years, and (iii) to discuss plans for validation of EOS instruments and data products in the first few years after launch. In addition, there will be a half-day session devoted to posters and booths prepared by instrument teams and Interdisciplinary Science (IDS) teams. This is especially important at this time, since the NASA Research Announcement issued in September 1995 resulted in 128 new EOS investigators (bringing the IWG membership, consisting of all principal and co-investigators, to 656). There are now 54 IDS investigations and 19 instrument science teams.

The NASA Research Announcement (NRA) for supplementary activities to support the validation of measurements by EOS satellite sensors in the AM-1 time frame is scheduled to be released sometime in February 1997. This NRA will also solicit proposals for investigations as part of NASA's Global Data Integration and Validation Program, an MTPE Research and Analysis Program. The tentative schedule includes submission of proposals by mid-April and selection of investigations in July.

Finally, I am happy to report that Dr. P. K. Bhartia has been selected as EOS Chemistry Project Scientist, replacing Dr. Jim Gleason, who has served effectively as Chemistry Project Scientist for the last 2 years (plus an additional 2 years as Deputy). Dr. Bhartia is a nationally recognized scientist with expertise in satellite instrumentation and data analysis. He has extensive knowledge of issues of atmospheric chemistry, he is the TOMS Earth Probe Project Scientist, and he is Head of the Atmospheric Chemistry and Dynamics Branch in the Laboratory for Atmospheres. Jim has decided to step down as Chemistry Project Scientist so as to focus once again on full-time scientific research.

—Michael King
EOS Senior Project Scientist

NASA Earth System Science Fellowship Program

This Fellowship Program (formerly the Global Change Research Fellowship Program and the Earth Science Graduate Student Research Program) targets students pursuing graduate degrees in fields supporting the study of Earth as a system. Applications for research on climate and hydrologic systems, ecological systems and dynamics, biogeochemical dynamics, solid Earth processes, human interactions, solar influences, and data and information systems will be considered. Applications are due March 12, 1997. NASA awards about 50 new fellowships in September of each year to coincide with the start of the Fall academic semester at U.S. universities.

This announcement and accompanying application forms are available electronically via the Internet at the Mission to Planet Earth homepage: http://www.hq.nasa.gov/office/mtpe under "Publications and Education Programs," and via anonymous ftp at ftp.hq.nasa.gov/pub/mtpe.

A paper copy of this announcement will be available only to those who do not have access to the Internet by calling (202) 358-3552 and leaving a voice mail message with your full name and address, including zip code, and telephone number, including area code.

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EOS PM-1 Advanced Microwave Scanning Radiometer (AMSR) Science Team Meeting

— **E. Lobl** (elena.lobl@msfc.nasa.gov), Team Coordinator, Earth System Science Laboratory, University of Alabama in Huntsville; EOS PM-1 AMSR homepage: wwwghcc.msfc.nasa.gov/AMSR

The third U.S. EOS PM-1 AMSR Science Team meeting was held 22-23 October 1996, at Goddard Space Flight Center. The first day was dedicated to team business and Algorithm Theoretical Basis Document (ATBD) status reports from all team members. The EOS PM Project Office updated the team on the hardware status. The second day was taken up by a data types presentation given by G. Cox, EOSDIS, and software discussions led by D. Conway, EOS PM-1 Software Lead Engineer.

The meeting started with Michael King, EOS Senior Project Scientist, showing the ATBD status of the other EOS instrument science teams. He gave details of what is expected of the ATBDs and the peer review presentation. The peer review will be scheduled for late February 1997.

Marty Donohoe, EOS PM Project Manager, gave the team an update on the common spacecraft contract. TRW, the spacecraft contractor, will conduct the bus requirements review in December 1996, and the preliminary design review (PDR) in April 1997. The interface control document, between AMSR and the spacecraft, is complete with few TBDs remaining.

Bernie Graf, PM Project AMSR Instrument Manager, reported on the EOS PM-1 AMSR hardware status. The meeting in Japan the last week of October with Mitsubishi Electric Company (MELCO) closed two of the main hardware issues: the thermal problem raised by the accommodations of the control unit, and the antenna tiedown points (two versus three points). He then showed measured EOS PM-1 main reflector and cold sky reflector antenna patterns. The ADEOS II AMSR Critical Design Review (CDR) will be held in December 1996 and the EOS PM-1 AMSR CDR a year later. The scheduled delivery of the instrument to the PM-1 spacecraft is June 1999.

The ATBD status presentations followed. Frank Wentz presented the Level 1C brightness temperature and the ocean suite ATBD status. Chris Kummerow talked about the highlights of the precipitation ATBD. Don Cavalieri and Joey Comiso discussed their work on developing the hybrid sea ice algorithm, and the plans for their joint ATBD. Al Chang and Eni Njoku presented their work on their respective documents: snow water equivalent/depth and the land standard products (surface soil moisture, effective surface temperature, and vegetation water content).

Frank Wentz presented the plan for the Level 1C data record. This record includes a header (time, orbit number, incidence and azimuth angles, location information, and surface classification) and retrieved brightness temperatures with four distinct resolutions: the 6.9, 10.7, 18.7, and 36.5 GHz channel resolutions. Suggestions from the team were to add a fifth resolution: the 89 GHz. Wentz also showed the status of the Level 1C data set simulator: a preliminary simulator exists but it does not have data for all channels. An image created from one of the channels of the preliminary simulator shows the correct orbit and the correct land type.

In the ocean suite ATBD, Frank Wentz, as the leader of the group, presented the complete models that will be part of the theoretical background to the ocean suite algorithm. In the atmospheric model he uses Liebe 1985 for the oxygen, a modified Liebe 1985 for the water vapor, and Rayleigh absorption for the cloud water components. For the specular sea surface model he recalculated the dielectric constant from 14 sources

of data and found a 2 K difference from the Klein and Swift dielectric constant value. For rough sea surface, Wentz formulated a model that assumes sea foam to have blackbody characteristics and allows a pixel to have fractional foam coverage. Using all these models in his 'AMSR TB model' and the initialization data for sea surface temperatures, wind speeds, cloud layer heights, and radiosonde profiles, he obtains Tb's for ocean scenes. After adding radiometer noise Wentz uses the standard least squares regression to converge to the ocean standard products: SST, wind speed, columnar water vapor, and columnar cloud water estimates. The retrieval errors for these estimates are well within the EOS AMSR specifications. One of the important components in this model, the effect of wind direction, is yet to be added. In the ATBD, Wentz will show a comparison between the linear statistical regression algorithm and the maximum likelihood estimator. The other group members (Ferraro and Wilheit) will contribute to the calibration/validation and historical perspective sections.

C. Kummerow, leader of the precipitation ATBD group (Ferraro, Kummerow, and Wilheit), presented the highlights of their document. The products generated with the precipitation algorithm are instantaneous rainfall intensity on a pixel-by-pixel basis (Level 2) and estimates of monthly totals on a 5°x5° basis (Level 3). In addition to rainfall intensity over the ocean, profiles of the hydrometeors will be classified as convective or stratiform (at Level 2). The three components of the algorithm are: ocean component (Level 2), land component (Level 2), and monthly rainfall accumulation (Level 3). In the ocean algorithm component the brightness temperature field is convolved with the AMSR measured antenna gain functions to produce a set of possible cloud profiles. These profiles together with their respective brightness temperatures form the database used in the precipitation retrieval over ocean. The precipitation profile retrieval method is an integral version of the minimum variance solution; it employs a Bayesian inversion methodology, and it is computationally efficient.

Rain over land will be detected by the depression of the brightness temperature caused by precipitation-sized ice particles and/or large rain drops. The magnitude of this depression is proportional to the rain rate. The basis for the retrieval over land comes from N. Grody's work at NOAA. Grody developed a global scattering index at 85 GHz for use with the SSM/I sensor. R. Ferraro built upon Grody's study and developed a more robust set of relationships to be used for detection of rain over land from SSM/I. Ferraro also rederived the relationships to separate rain from snow and deserts and introduced a new screen for semiarid regions. To retrieve instantaneous rain rate, the scattering index has been calibrated with ground-based radar measurements. Cluster analysis and principal components analysis will be used to examine if the lower frequency channels on AMSR are more efficient in separating rain from snow and deserts.

The third component of the precipitation algorithm is the monthly rainfall accumulation. The standard product is monthly rainfall totals for a 5°x5° area. The embedded Level 2 oceanic rain algorithm is based on the radiative transfer model, where the initial distribution of hydrometeors, the atmospheric temperature structure, the water vapor profile, and the surface reflectivity are specified. The resulting freezing level is used to compute the possible rain rates, valid over a specific dynamic range (depending on the frequencies used). Each of these rain rates is corrected for beam filling and then accumulated into histograms for the area and time period (nominally 5°x5° by one month). A maximum likelihood estimator is used on a histogram to compute the parameters of the log-normal distribution of rain rates. The Level 3 standard product is the estimate of the monthly rainfall accumulation in this 5°x5° area.

The sea ice group, D. Cavalieri and J. Comiso, presented a flow diagram for their sea ice concentration standard product algorithm. After ingesting the Level 1C brightness temperatures, the 'PR/GR' routine will be used initially to compute concentration. A filter will determine the thin ice and emissivity anomaly areas, and the sea ice concentration will be recomputed (for those areas) with the '19V vs. 37V' routine. Plans for the other two standard products (sea ice temperature and snow depth on sea ice) algorithms were also discussed.

Al Chang summarized the snow water equivalent algorithm, the basis for the snow ATBD. The Nimbus-7 SMMR snow algorithm is the starting point for the current algorithm. The radiative transfer equation includes radiation loss, reradiation, and scattering. The assumptions made (due to lack of snow ground truth

information) are: 1) a uniform, spherical grain size, 2) incoherent scattering by snow grains, and 3) a mean snow density. The final algorithm will address issues such as: consideration of a dense media model, a snow particle distribution (instead of assuming uniform particles), snow growth model and different classifications, and corrections for fractional forest cover and elevation. The Microwave Workshop (St. Lary, France, 1993) recommendations for a snow water equivalent global algorithm are the inclusion of the following: snow metamorphism, vegetation cover, snow on warm ground, signal saturation at 150–200 mm, and mixed pixels. Finally, Chang presented estimated versus measured snow water equivalent data; after applying the forest cover correction, the estimates come much closer to the measured values.

E. Njoku presented the retrieval algorithm for the land surface parameters: surface soil moisture, surface temperature, and vegetation water content. The simplified radiative transfer model for surface observations from space has two components: the atmospheric temperature term and the soil/vegetation term; both terms are modified by the atmospheric opacity (a function of water vapor), soil reflectivity (a function of soil moisture) and vegetation canopy opacity (a function of water content). Njoku determines the regression coefficients from a simulated data set, and then uses a nonlinear, iterative retrieval method (minimization of χ^2 merit function) to retrieve each of the land surface parameters.

Software and EOSDIS issues took up the entire second day (from 8:30 until noon). K. Cox from the EOSDIS office presented an overview of the role of ECS metadata, discussed the function and components of Earth Science Data Types (ESDTs), and described the ECS metadata population process. The presentation started with the definition of a granule. The team decided that, for PM-1 AMSR, a granule will consist of data in one full orbit. A question still exists on the definition of an orbit: starting point, overlap scans,.... . M. Schwaller from EOSDIS discussed the availability of the ancillary data needed by the team.

D. Conway wrapped up the meeting with discussions on toolkit implementation, SCF and Team Algorithm Development Plans reviews and inputs, and finally the EOS PM-1 web page. She listed several action items which can be viewed by the team members on the "Team Only" page.

The next AMSR meeting will take place the day after the ATBD peer reviews in mid-March 1997.

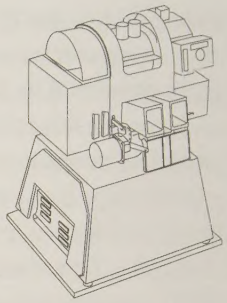
NOTE

The Lightning Imaging Sensor (LIS) science team and MSFC DAAC announce the availability of global lightning data sets from the Optical Transient Detector (OTD) experiment. The OTD is a prototype of the LIS instrument scheduled to fly on TRMM in 1997. OTD was launched by the Orbital Sciences Corp. in April 1995 and is a payload on the MicroLab1 satellite. The current data release contains 15 months (April 1995-June 1996) of reprocessed data. You can learn more about this data set at: http://wwwdaac.msfc.nasa.gov:/userservices/whatsnew.html, or contact Steve Goodman (steven.goodman@msfc.nasa.gov), tel.: (205) 922-5891; Fax: (205) 922-5723.

KUDOS

Dr. Heidi M. Sosik, Woods Hole Oceanographic Institution, recently won a Presidential Early Career Award. Sosik received her undergraduate degree from MIT working with Dr. Penny Chisholm. Supported by a NASA Global Change Fellowship, she received her Ph.D. from Scripps with Greg Mitchell, an EOS Principal Investigator, as her advisor. She was also recently chosen as an EOS Young Investigator and works cooperatively with the Brewer/Goyet IDS team. The MTPE/EOS community wishes to congratulate Dr. Sosik on her recent accomplishments.

Clouds and The Earth's Radiant Energy System (CERES) Science Team Meeting



— **Bruce R. Barkstrom** (brb@ceres.larc.nasa.gov), Co-Principal Investigator, and **Gary G. Gibson** (g.g.gibson@larc.nasa.gov), NASA Langley Research Center

The 14th Clouds and the Earth's Radiant Energy System (CERES) Science Team meeting was hosted by David Randall of Colorado State University on September 11-15, 1996, in Fort Collins, CO. The focus of the meeting was CERES instrument status, algorithm development, and validation plans. CERES schedules are being driven by the Tropical Rainfall Measuring Mission (TRMM) launch, now planned for November 17, 1997. The Science Team guides the definition of the CERES instrument and science studies to provide a climate data set suitable for examining the role of clouds in the radiative heat balance of the climate system.

Bruce Wielicki, CERES Co-Principal Investigator, opened the meeting with an Earth Observing System (EOS) program status report. He also called attention to the cover article on the CERES project in the May issue of the *Bulletin of the American Meteorological Society*. This article describes CERES as an investigation to examine the role of cloud/radiation feedbacks in the Earth's climate system. The CERES broadband scanning radiometers are an improved version of the Earth Radiation Budget Experiment (ERBE) radiometers. The CERES instruments will fly on several NASA EOS satellites starting in 1998 and extending over at least 15 years. The CERES science investigations will provide data to extend the ERBE climate record of top-of-atmosphere (TOA) shortwave (SW) and longwave (LW) radiative flux. CERES also combines simultaneous cloud property data derived using EOS narrowband imagers to provide a consistent set of cloud/radiation data, including SW and LW radiative fluxes at the surface and at several selected levels within the atmosphere. CERES data should provide radiative fluxes with a factor of 2-to-3 less error than the ERBE data.

CERES Instrument Status

Robert B. Lee III (LaRC), Lou Smith (LaRC), and Kory Priestley (Virginia Tech) presented the instrument status report. The CERES Proto-Flight Model (PFM) instrument was successfully integrated on the TRMM spacecraft. Instrument weight and power are slightly below the TRMM allocations. Mechanical and electrical integration on TRMM were completed in March, and full comprehensive functional tests verified instrument operation. Electro-Magnetic Compatibility (EMC) tests were successfully completed in July. Spacecraft level tests indicated no adverse effects on CERES science data with anticipated signal strengths of the spacecraft and the other TRMM instruments. Separate tests with the Precipitation Radar indicated no effect on the CERES data. The azimuth gimbal experienced a stall in one particular region when the instrument was cantilevered out from the spacecraft. The stall occurred randomly, and did not occur in the flight-like orientation. A procedure is in place to test extrication from the stall should it reoccur. The azimuth encoder showed a preset azimuth position upon power up. The problem was isolated in the control logic electronics and was solved via an instrument reset.

EOS-AM Flight Model 1 (FM1) assembly is complete and FM2 assembly is continuing. FM1 detector offset and drift problems were resolved. Process changes (de-airing of epoxy) were made to avoid a delamination of the flake from the substrate due to trapped air bubbles. All mechanical and structural mechanisms survived vibration testing without problems. Electronics damage occurred when two boards came in contact. Board spacing was increased to correct the situation. Several changes were made to sensor electronics to reduce susceptibility to electromagnetic radiation.

The TRMM spacecraft level testing continues. Thermal/vacuum tests began September 7; vibration testing begins in January 1997. The spacecraft will be shipped to Japan in April 1997 and will be ready for launch by August 1, 1997.

Data Management System

Jim Kibler presented the CERES Data Management System status report. He summarized Release 1 integration and test activities and status of Release 2 code development. Level 0 data from the TRMM Sensor Data Processing Facility (SDPF) have been processed on Science Computing Facilities to produce Bi-Directional Scan (BDS) and Instrument Earth Scans (IES) data products. This successful test demonstrated many of the processing steps which must be operational for the TRMM launch. Release 2 data products and architecture are mostly defined, and code development is in progress. In the near term, mission simulation tests will be conducted with live CERES data from TRMM, CPU-intensive subsystems will be optimized, and Release 2 algorithms will be finalized, coded, and tested. If the TRMM launch slips, additional design and code reviews will be considered.

Algorithm Theoretical Basis Documents (ATBDs)

The Release 2.1 CERES ATBDs have been completed for all subsystems and placed on a WWW page at LaRC. Major changes from Release 1 include updating subsystem input data, data product catalogs, data flow charts, and product size and processing time estimates; adoption of the 1° equal-angle EOS grid system; deleting surface products from the ERBE-like processing; adding a subsystem for gridding geostationary narrowband radiances; improved algorithms for cloud mask and cloud optical property retrievals; algorithm improvements for the Surface and Atmospheric Radiation Butget (SARB) subsystem; and use of International Satellite Cloud Climatology Project (ISCCP) B1 data for temporal interpolation. A peer review of the ATBDs is now underway through the EOS Project Science Office and will be followed by an oral panel review on November 19-21, 1996. Release 2 will be finalized following the review process.

Validation

The CERES Validation Plans are currently being developed. Following a peer review in late 1996, the Validation Plans will be made available on the WWW in the Spring of 1997. In the interim, a separate document containing the Validation Plan Summary Charts for each major subsystem was developed to accompany the ATBDs. This CERES Validation Plan Summary provides the basic elements of each plan in a common format for all the subsystems. This includes a concise overview of the data to be validated, the validation techniques and approach to be applied, and data sources to be used for validation. There are five major data types to validate: instrument broadband radiances, TOA radiative fluxes, surface radiative fluxes, atmosphere radiative fluxes, and cloud properties. Validation will be accomplished by seven major techniques: on-board calibration, theoretical sensitivity studies, pre-launch satellite data surrogates, internal consistency checks, surface observations, other satellite data, and field campaigns.

Because of the emphasis placed on validation, Tom Ackerman (Penn State) gave an invited presentation on "Ground-Based Remote Sensing of Cloud Properties." He discussed various ground-based sensors including cloud radar and lidar systems, narrowband radiometers, sky imagers, and broadband hemispheric-view radiometers. Observable cloud properties using ground-based sensing include cloud boundaries (top and bottom), cloud amount, mean particle size, particle phase, SW and LW optical depth, and liquid water path. He outlined retrieval techniques for cloud microphysics focusing on bulk retrievals, use of Doppler radar pulse pairs, and use of Doppler radar spectra. An aircraft/surface radar experiment at Penn State in October will provide data to verify the surface-based cloud property retrievals.

Wielicki led a discussion of the various aircraft, remotely piloted vehicles, Atmospheric Radiation Measurement (ARM) instrument packages, and other instruments that will be used to validate cloud properties. He concentrated on identifying cloud regimes that do not have sufficient validation sources in the current plan, namely subtropical oceans, deserts, high-latitude oceans (storm tracks), and tropical land. A need for additional lidar/radar/radiometer combinations was recognized. Tom Ackerman discussed Penn State's long record of radar-based effective radii retrievals as a function of height. CERES personnel will participate in their October field experiment to acquire satellite data to complement aircraft- and surface-based observations for use in cloud property retrievals.

Working Group Reports

Cloud Working Group: Decided to run both daytime and nighttime cloud algorithms when the solar zenith angle is between 78° and 80°. This will allow some ability to pick and choose between algorithms and do some consistency and bounding checks to ascertain if the results from the daytime are reasonable.

Surface and Atmospheric Radiation Budget (SARB) Working Group: Made changes to a list of parameters in the Single Satellite Footprint (SSF) product, which has the imager-based cloud properties and broadband measurements. Discussed the characteristics of the ancillary meteorological data to be used for all CERES processing, which are to be acquired from the Data Assimilation Office (DAO) at the GSFC. Man-Li Wu (GSFC) described the characteristics of the data set currently available from the DAO, and the significant enhancements to be made before the TRMM and EOS launches. Tom Charlock inquired if water vapor channel IR radiances from satellites will be assimilated directly in the DAO analysis for water vapor; such assimilation is done by the European Center for Medium-Range Weather Forecasts (ECMWF) and is claimed to substantially improve the water vapor profile. The water vapor profile is critical for the determination of diabatic heating by CERES. Wu indicated that the water vapor IR radiances will not be used for such direct assimilation by DAO, but she was confident that the water vapor retrievals for AM-1 and PM-1 will be much better than the present ones. This remains a major area of concern for cloud/radiation studies.

Time Interpolation and Spatial Averaging (TISA) Working Group: Discussed algorithm changes, code development, validation plans, and ongoing temporal and spatial averaging studies. Takmeng Wong compared results from a DAAC run of the ERBE-like TISA code with ERBE. Slight discrepancies were seen in the monthly means from the two data sets, and possible causes were discussed. All TISA subsystems are on target for delivery to meet TRMM schedules.

Investigator Presentation Highlights

Bruce Wielicki (LaRC): Commented that most algorithms that deal with cloud overlap are considered "high risk" and will likely not be implemented until a later release. These algorithms are still in the development stage. Most also require Moderate Resolution Imaging Spectroradiometer (MODIS) wavelengths and/or resolution, rather than the Visible and Infrared Scanner (VIRS) products, so implementation is not really necessary until EOS AM/PM.

Bryan Baum (LaRC): Showed that timings on an SGI R10000 single processor are down to 0.5 hours per hour of VIRS or Advanced Very High Resolution Radiometer (AVHRR) data for the CERES cloud property retrieval subsystem. IBM Explorer is an effective visualization tool, especially for global data. The CERES-developed Satellite Imagery Visualization System (SIVIS) used for cloud algorithm testing has been distributed to the team.

Tom Charlock (LaRC): Compared surface SW fluxes computed with the Fu-Liou code and measurements from sites in north-central Oklahoma and at the Boulder Atmospheric Observatory (BAO) tower. Computed fluxes are consistently higher than measured fluxes for clear-sky conditions. There are significant differences among the many surface flux measurements in the ARM Extended Shortwave Experiment (ARESE). Similar discrepancies noted by the ARM team have been reported in the on-line CAGEX (CERES/ARM/Global Energy and Water Cycle Experiment, GEWEX) activity: http://snowdog.larc.nasa.gov/cagex.html. Further work is needed to clarify absolute accuracy of the different surface radiation sensors.

Jim Coakley (Oregon State Univ.): Completed new spatial coherence routines for retrieving cloud structures. The new methodology requires only a single pass through the observations to analyze the cloud properties.

Dominique Crommelynck (Belgium): Presented the results of a paper by S. Dewitte *et al.* in which radiation budget estimates were derived at the highest possible time/space resolution from Meteosat images and compared to ERBE results. This work explores combining broadband radiation data from satellites such as ERBE, Scanner for Radiation Budget (ScaRaB), and CERES with narrowband geostationary satellite data to enhance spatial and temporal resolution.

Jennifer Francis (Rutgers Univ.): Discussed the need

for 4.0, 4.46, and 4.52 μm channels from MODIS in retrieving nighttime polar clouds. MODIS channels will include these wavelengths, some new wavelengths for SARB, and other channels needed for cloud retrievals.

Richard Green (LaRC): Showed the final validation results of a new set of ERBE-like angular distribution models (ADMs) constructed from Nimbus-7 data and the Radiance Pairs Method (RPM). The new ADMs eliminated albedo growth to the limb, reduced latitudinal bias, and reduced cloud cover growth with viewing zenith. Applying the new ADMs to a month of ERBS data changed the daily global SW flux by 5%, depending on the local time of the orbit (i.e., solar zenith angle sampling). However, the monthly global flux was almost unchanged.

Qingyuan Han (S. Dakota School of Mines & Technology): Emphasized the need to explicitly define effective radius and diameter when doing microphysical retrievals/validation. At least 6 different mathematical definitions are in the literature. He also discussed the effect of varying particle shapes on scattering/measured radiances and presented results from a simulation of bullet rosettes and hexagonal columns and their respective scattering behavior.

Anand Inamdar (representing V. Ramanathan, Scripps): Presented a new LW surface flux parameterization for cloudy skies that uses a matrix for cloud overlap structure based on synoptic cloud climatology reports. Cloud heights are assumed in accordance with the International Cloud Atlas. Cloud radiative forcing at the surface is uncorrelated with that at the TOA, except for distinct cloud patterns. For each cloud type (low, mid, and high), the cloud radiative forcing at the surface shows distinct correlations with the total precipitable water. Nearly 60-70% of the cloud forcing at the TOA and about 70-90% of the cloud forcing at the surface occurs in the window region.

Michael King (GSFC): Briefed the team on the Arctic Radiation Measurements in Column Atmosphere-surface System (ARMCAS), a small, focused field campaign designed to better understand radiative processes in the Arctic and to serve as a pilot study for the Arctic First ISCCP Regional Experiment (FIRE)-III and Surface Heat Budget of the Arctic Ocean (SHEBA).

Norman Loeb (Oregon State Univ.): Reported on the applicability of 1D radiative transfer theory for retrieving cloud properties. He noted significant differences between the 1D theory representation of the cloud reflectance field and actual observations, even for overcast marine stratus cloud layers. The 1D model underestimated reflectances at nadir and systematically overestimated (by 20-30%) reflectances in the forward scattering direction at moderate and low sun elevations. In the backscattering direction, the 1D model provided an accurate (within 10%) representation of the observed reflectance.

Pat Minnis (LaRC): Reported on cloud algorithm development using the 12 μm split window technique. This wavelength helps to eliminate ambiguous solutions that can occur in the backscatter direction when using the Visible, Infrared, Near-infrared Technique (VINT). The backscatter problem seems to occur in thinner clouds. Thin cloud over thick cloud situations can also be explained using information gained from the split window technique.

Dave Randall (Colorado State University): Presented data and rationale to promote the use of the diurnal cycle as a testbed for large-scale models. The forcing of the diurnal cycle, i.e., the diurnal variation of solar radiation at the TOA, is external to the climate system, is well understood, and can be specified very accurately. The response to the diurnal cycle is often quite strong such as in the case of diurnal convection and precipitation over tropical land masses. The diurnal cycle is periodic, so that compositing can be performed in a highly objective manner. Finally, the period of the diurnal cycle is short, so that many realizations can be captured by a relatively brief simulation or observational record.

David Rutan (LaRC): Presented surface optical property maps that will be part of the SSF. "Point and click" maps for *a priori* global surface spectral reflectance and broadband emissivity are maintained by CERES on the WWW at: http://tanalo.larc.nasa.gov:8080/surf_htmls/SARB_surf.html. CERES is seeking advice on (a) seasonal interpretation of the surface reflectance maps, (b) the solar zenith angle dependence of reflectance, and (c) spectral bi-directional reflectance functions (BDRFs). The 17 surface types used in the International Geosphere-Biosphere Program (IGBP) will be adopted for SARB processing, and optical properties will be

derived for each surface type in all Fu-Liou bands and for the broadband and window in the LW region. He also showed comparisons with CAGEX data over Oklahoma. Charles Whitlock (LaRC) has begun a helicopter-based program to determine spectral BDRFs (FieldSpec FR 350-2500 nm) and broadband albedo.

Lou Smith (LaRC): Presented results of ScaRaB validation studies. He analyzed the errors resulting from computing daily or monthly means of outgoing LW on the basis of restricted temporal sampling. He compared ERBE and ScaRaB results to quantify regional sampling errors and developed methods to deal with similar sampling problems that could be encountered on CERES.

Shi-Keng Yang (NOAA): Compared CAGEX LW fluxes with corresponding fluxes from NOAA's medium-range forecast model and regional spectral model. The data were also compared with NCEP Reanalysis. Comparisons for both outgoing and downward LW were good for clear skies, but not as good for cloudy skies.

David Young (LaRC): Presented new ERBE-derived monthly, regional clear-sky LW thresholds for improving the CERES ERBE-like clear-sky processing. Reprocessing one month of ERBS data with the new thresholds substantially reduced the number of regions without a clear-sky classification.

Ming-hua Zhang (representing Bob Cess, SUNY Stony Brook): Discussed the atmospheric SW absorption bias in the NCAR CCM and possible causes. The CCM underestimates atmospheric SW absorption by 20 Wm^{-2} (global mean) compared to collocated TOA ERBE data and Global Energy Balance Archive (GEBA) surface observations. Direct aircraft measurements of SW absorption during ARESE indicate that the cause is not a clear-sky problem, but rather one of cloud absorption.

Science Team Logistics

The next CERES Science Team meeting is scheduled for April 18-21, 1997, at the Langley Research Center. Major topics will include instrument status for the TRMM launch and for the EOS satellites, the review of Release 2 ATBDs and validation plans, and software development and testing.

THREE NEW CD-ROMs

— **Susan Digby** (digby@pacific.jpl.nasa.gov), Jet Propulsion Laboratory

The JPL PO.DAAC is proud to present three new CD-ROM products. They can be browsed and ordered through http://podaac.jpl.nasa.gov.

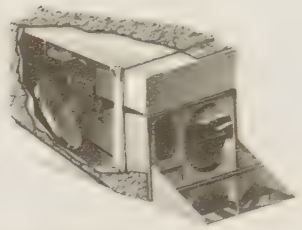
1) **AVHRR Oceans Pathfinder monthly global best SST CD-ROM (JPL, Miami)**—The NOAA/NASA AVHRR Oceans Pathfinder Monthly Sea Surface Temperature CD-ROM is a two-volume set containing monthly averaged sea surface temperature (SST) data and browse images derived from the NOAA Advanced Very High Resolution Radiometer (AVHRR) using the Pathfinder Version 3 algorithm. Data for both the ascending pass (daytime) and descending pass (nighttime) are available globally on equal angle grids of 4096 pixels longitude by 2048 pixels latitude, 2048 pixels longitude by 1024 pixels latitude, and 720 pixels longitude by 360 pixels latitude. These data have previously been referred to as 9-km data. These data are provided in the Hierarchical Data Format (HDF). Data for 1991 and 1992 are available now; additional CD-ROMs will be added to this collection as soon as the data become available.

2) **AVHRR monthly global MCSST CD-ROM (JPL, Miami)**—The AVHRR Monthly Global MCSST CD-ROM set contains monthly mean values of multichannel sea surface temperature (MCSST) data calculated from the NOAA Advanced Very High Resolution Radiometer (AVHRR). Data for both the ascending pass (daytime) and the descending pass (nighttime) are given in the Hierarchical Data Format (HDF) and have a spatial resolution of 2048 pixels/360 deg or 5.689 pix/deg. These data have previously been referred to as 18 km data. Browse images of this data are also available on the CD-ROMs. Data from 1981 to 1995 are available now. Additional CD-ROMs will be added to this collection as soon as the data become available.

3) **A collection of ocean tide models on CD-ROM (U of Texas, JPL *et al.*)**—This CD-ROM contains ten global ocean tide models which have been developed for the research community. The models were developed by the analysis of the precise measurements from the TOPEX/Poseidon altimeters, and as a result of parallel developments in numerical tidal modeling and data assimilation. The CD-ROM contains the following models:

(Continued on page 32)

Moderate-Resolution Imaging Spectroradiometer (MODIS) Science Team Meeting Summary



— **David Herring** (dherring@pop900.gsfc.nasa.gov), Science Systems & Applications, Inc.

The MODIS meeting (October 10-11, 1996) was chaired and called to order by Vince Salomonson, MODIS Team Leader. The complete set of these minutes, along with attachments, is available in Portable Document Format (PDF) on the MODIS Home Page, at http://modarch.gsfc.nasa.gov/MODIS/MODIS.html.

EOS Project Science Status Report

Michael King, EOS Senior Project Scientist, announced that four of ten chapters to be included in the *EOS Science Implementation Plan* have been received. The plan is expected to be completed by Spring 1997 and will be available both as hard copy and as a document available via World Wide Web.

King told the Team that the *EOS Data Products Handbook* is in the final stages of review. The handbook describes all EOS AM-1 and TRMM data products and presents data flow diagrams. He noted that the MODIS sections of the handbook are still needed.

EOS AM Platform Status

Chris Scolese, EOS AM Project Manager, reported that the EOS AM-1 platform is still on track for a June 1998 launch. Flight hardware is currently being delivered and installed, and spacecraft integration has begun. The launch vehicle and launch facilities are also progressing well. Scolese said that deliveries of ASTER and CERES are imminent. MISR is making good progress, but still awaits system level tests. Scolese is concerned that the MOPITT schedule is currently very tight, and MODIS development is now lagging.

Scolese showed a chart listing the top ten issues facing EOS AM-1. Issue #2 is that the MODIS schedule contingency is eroding. Testing of the MEM (main electronics module) continues and the resistor networks were to be replaced in November. Scolese assured the Team that we will not launch a compromised instrument. He feels that although it will not be perfect, MODIS will be one of the best Earth sensors ever flown. Scolese pointed out that Valley Forge is closing down in June 1998. This drives the EOS spacecraft schedule somewhat to be fully integrated, tested, and ready to launch before that date.

Scolese stated that the MODIS flight model 2 (FM-2) was deleted as directed in the POP 96 budget; however, the Project Office is still pursuing an advanced technology MODIS instrument, or AMODIS. He stated that the AM Project Office is planning to implement a small yaw-and-roll maneuver for calibration purposes. He said that in order to move forward on planning for maneuvers there needs to be a consensus among all EOS instrument teams in favor of the maneuver. Scolese stated that it is cheaper to implement a joystick approach to the spacecraft maneuvers, rather than creating new software at this point. Yoram Kaufman, EOS AM Project Scientist, stated that he will deliver a consensus letter on October 18 after the Science Working Group for the AM Platform (SWAMP) meeting.

EOSDIS Plans to Support Development of At-Launch Production Software

John Dalton, ESDIS deputy project manager, reported that the replanning of EOSDIS is in progress, but no final decisions have been made yet. He stated that the replanning process includes a detailed review and feedback from the EOS instrument teams and DAACs. Dalton presented an overview of the replan strategy. There has been a significant slip—from December 1996 to May 1997—in the scheduled delivery of Release A of the science processing segment of ECS (EOSDIS Core System) in the data server portion. According to Dalton, one factor contributing to the slip was underestimation of the code size required for the data server at the Critical Design Review (CDR). Another factor was that there were COTS (computer off-the-shelf) software

product incompatibilities across vendor platforms. Also, there has been difficulty recruiting and retaining expertise in key technologies, such as C++ and Distributed Computing Environment (DCE). Dalton concluded that planned recovery through parallel development is not feasible due to serial dependencies within the system. As a result of the above problems, ECS failed its Test Readiness Review (TRR) on August 5-6.

Mark Abbott asked how users will access EOS data—via the Internet? Dalton responded affirmatively. Abbott said he is concerned that Internet throughput will go down too far, greatly hampering electronic data distribution. Specifically, he is concerned that the system won't deliver Level 3 products, which he feels users will want.

New EOS AM Project Scientist

Salomonson introduced Yoram Kaufman, the new EOS AM Project Scientist, succeeding Piers Sellers. Kaufman began his presentation by showing an organization chart of the EOS AM Project Office personnel. Jon Ranson is the Deputy AM Project Scientist, Jim Collatz is the Associate Project Scientist in relation to IDS investigations, and Francesco Bordi is the AM project liaison.

Regarding MODIS instrument testing at Valley Forge, Kaufman asked for help from the MODIS Team in defining a simple, overall check of the system. Kaufman said he supports on-orbit maneuvers as part of the optimization of the whole MODIS calibration concept. He feels that steps should be taken to minimize risk to the platform; and alternatives to maneuvers should be prepared in case they are needed during the life of the mission.

SDST Status Report

Ed Masuoka, Science Data Support Team (SDST) leader, reported that the Version 1 software deliveries have slipped 3 to 4 months. He told the Team that all software except the Level 3 atmosphere products are on schedule for the Version 1 delivery deadline. He showed a milestone chart of the software delivery timelines. He noted, however, that there is no Release A system at the DAACs that can support MODIS' integration and testing needs.

Regarding the Release A slip, Masuoka pointed out that this creates more time for the Science Team software deliveries, and allows for adequate time for SDST to conduct its tests in the Team Leader Computing Facility (TLCF). However, the slip causes a compressed testing schedule at the DAACs. To compensate, he suggested that the MODIS Team define its most important tests and identify dedicated test strings. The Team should work with SDST to develop more-streamlined testing procedures, and plan on working with several testing shifts at the DAAC. Masuoka said that Version 1 testing will parallel the Version 2 science software delivery. The burden will be on SDST and the science software developers to support changes in the two versions of the software.

Masuoka added that he is unsure whether ECS will be able to produce MODIS products at launch, which is a serious concern. Also, network bandwidth is a concern; however, Masuoka said that the network links ESDIS plans to install next year should provide the needed bandwidth. Masuoka would like all open issues that affect science software developers to be resolved by December 1996—including production rules syntax, HDF-EOS support for MODIS' nested integerized sinusoidal grids, and the standard data product toolkit (SDP-TK) compatibility across all products.

Geolocation Workshop

Alan Strahler listed the following as potential sources of geolocation error: position of center of mass of the spacecraft, spacecraft attitude, and pointing accuracy of the MODIS instrument. He feels that the team must understand the sources of dynamic geolocation error so that these errors may be corrected with software. He strongly advocated establishing ground control points to measure and remove geolocation bias. These ground control points should be stratified with respect to cloud cover, latitude and longitude, and day/night.

Strahler recommended developing a phased approach. He stated that we must characterize MODIS' geolocation bias early so that by the time of launch a system will be in place to give the static error to within 10 meters. He believes that the EROS Data Center (EDC) has the resources needed to do this at launch. Strahler said that MODIS could use the AVHRR control points library. He asked Jeff Eidenshink to report back on EDC's control point holdings.

At-Launch Production Scenarios Workshop

Paul Menzel reported that the following question was raised during this workshop: What should be the process for changing algorithms, reprocessing, and allocation of resources? Menzel suggested that there will not be a stable production environment at launch and that the algorithms will likely change dynamically. He feels that tracking these changes will be very important. Menzel presented the National Environmental Satellite Data and Information Service (NESDIS) procedure for reviewing products in the post-launch period.

Tools for Averaging and Subsetting Workshop

At this workshop ECS gave an overview of the software tools being developed and made available for averaging, subsetting, map projections, and identifying key deficiencies of data products. John Townshend noted, however, that resampling and remapping procedures are not currently being considered. He asked who will develop the software tools for these procedures?

Townshend identified two issues that need to be addressed: 1) EOS data users may get far more data than they request from EOSDIS; and 2) geographic requests for data that cross granules will require multiple orders and only rectangular areas can be requested. Before launch, Townshend would like to test the ECS toolkit on simulated MODIS data.

Townshend added that requests involving multi-temporal images may be difficult; and he is concerned about the lack of tools facilitating multisensor data use. He stated that there is general agreement that there needs to be better communication between ECS and the Science Team. He feels that the MODIS data sets as generated through EOSDIS will likely fail to satisfy many users outside the MODIS Science Team because there is a lack of tools for pre-processing. Skip Reber pointed out that there is a forum for communication between the science teams, ESDIS, and the DAACs, but perhaps the right people are not attending that forum (Data System Working Group).

Quality Assurance Workshop

Wayne Esaias stated that the goal of this workshop was to assess the status of the MODIS Quality Assurance (QA) Plan, which is required by ECS in about one month, so that the team can implement the functionality which will provide MODIS product developers with the information and system for assessing the quality of the MODIS data products. Esaias reported that MODLAND has a draft of their QA plan out for comment; they expect to release their revised draft by November 15. The Ocean Group has met and discussed QA, but has yet to produce a draft plan. The Atmosphere Group has not yet begun to address quality assurance (QA). Esaias stated that it is possible to get convergence within the MODIS Science Team on metadata quality flags. He said he expects that all Version 1 code will contain flag information and software needed to generate QA flags.

Esaias stated that there is concern regarding the readiness of the DAACs to run the QA procedures. He said there is a wide range of opinions as to where QA should take place and how new QA information gets put back into the database. Another concern is the complexity of the post-production process.

Interactions for EOS PM-1

Regarding testing and characterization of the MODIS instruments, it was determined that there are no significant differences between the MODIS Protoflight Model (PFM), which will fly on EOS AM-1, and the MODIS Flight Model-1, which will fly on the PM-1 spacecraft, that make any difference to the Science Team. According to Robert Murphy, some deficiencies in the PFM were identified that could, in principle, be fixed. Among the correctable deficiencies are the D1 dichroic interaction with Bands 8 and 9, and the crosstalk in bands 31 - 36. It was also felt that the MODIS Calibration Chamber could be equipped with a zinc selenide (ZeSe) window, and that solar calibration could be re-introduced.

Regarding cross calibration, Murphy stated that the use of lunar calibration now seems unlikely. However, orbit phasing with other platforms could provide simultaneous views at the poles. Ed Zalewski, University of Arizona, will later provide better descriptions of the options for cross calibration. Murphy noted that EOS PM-1 has much lower specifications for pointing accuracy than does AM-1, which was "driven" by ASTER and MISR. He feels that the MODIS pointing specification for AM-1 and PM-1 is incorrect—it should be ten times better.

Algorithm Developers Workshop

Liam Gumley reported that the algorithm developers need a stable period for developing Version 2 software between December 1996 and the Version 2 delivery deadline. This will allow developers to integrate tools, data, and specifications and work on science algorithm development too. They will also need to better understand and plan for HDF-EOS. Gumley said there are two options for ancillary data: 1) National Centers for Environmental Prediction (NCEP) data could be obtained for Science Team members, who will be responsible for unpacking and resampling; or 2) use data from the DAO (Data Assimilation Office). Gumley stated that the DAO is responsive to users' needs. He said that good communication will be important during the algorithm test process. Developers will want to know test results in a timely manner. He suggested making certain selected results available on the Web.

Calibration Workshop

Phil Slater summarized discussions at the MODIS Calibration Workshop. Slater plans to validate the calibration coefficients using two independent vicarious calibration methods—one method is reflectance-based and the other is radiance-based. Slater proposed an intensive validation campaign during the A&E period. He said he is likely to conduct smaller campaigns at two-month intervals, and then one intensive campaign per year.

The first joint vicarious calibration field campaign—held at Lunar Lake and Railroad Playa in early June—compared TOA (top of the atmosphere) radiances. Team members from ASTER (from both Japan and JPL), MISR, MODIS, South Dakota State University, and University of Arizona participated. Preliminary results from that campaign are still being studied.

Slater introduced Ed Zalewski, University of Arizona, who proposed assisting Santa Barbara Remote Sensing (SBRS) in its absolute radiance calibration. Zalewski conducted a cross comparison of the calibration of SBRS' Spherical Integrating Source (SIS) during the month prior to their bulbs' burning out. He plans to bring back transfer radiometers to help SBRS verify its SIS and characterize MODIS' signal-to-noise ratio (SNR). He also wants to help verify the SIS' and MODIS' radiometric stability during ambient and thermal vacuum tests, as well as before and after vibration tests.

MODLAND Group Discussions

Chris Justice summarized the Land Group's deliberations. Regarding MODIS instrument tests, he said there is a need for an explicit timeline for tests from present to delivery, with scenarios to address any slips in the test schedule. He encouraged MCST and the MODIS Project to continue their current level of attention to SBRS' testing.

Following John Dalton's presentation on the delayed delivery of ECS, Justice stated that MODLAND is concerned that both team and community expectations will not be met in the first six-to-twelve months after launch. As a result, he feels there needs to be a coordinated MODIS/MODLAND strategy with timelines for securing the post-launch data stream needed for QA and validation. It is critical that the broader science community have access to MODIS data as soon as possible after launch. Justice said he is also concerned that ECS toolkits will fall short of the needs for MODIS team members and data users. Justice encouraged a Science Working Group for the AM Platform (SWAMP) initiative to address product-generation interdependencies under the phased ECS delivery.

Justice reported that geolocation is a major concern on the EOS PM platform. He said the bottom line is that the MODIS PM land products must have at least the same locational accuracy as the AM products.

Justice announced that by the next Science Team Meeting, MODLAND will have developed its QA plan and its QA implementation plan. Justice reported that MODLAND's validation plans are evolving rapidly towards a community validation initiative based around aircraft flights, continuous test site monitoring, and mini-campaigns. The Land Group would like to work more closely with other instrument and IDS scientists. For instance, MODLAND is planning to be an active participant in the upcoming LBA (Large-scale Biosphere-Atmosphere experiment in Amazonia) campaigns.

In response to questions concerning validation timing and planning, Justice said that, for contingency plan-

ning in terms of validation campaigns, the EOS Project must provide a first-cut assessment of realistic launch slip scenarios. Justice also stated that the Land Group at this time has no critical external logistic dependencies for validation in the first quarter after launch. However, it is critical that ESDIS provide sufficient data to support an effective QA activity immediately post launch and enough data to permit extensive validation during the first year.

Ocean Group Discussions

Wayne Esaias reported that the Ocean Group is very encouraged with the approaches being taken by SBRS, MCST, and the MODIS Project Office to ensure that MODIS meets our challenging science requirements. He stated that the ocean group is fully committed to the Level 1 mission requirements. He said that success in achieving the sea surface temperature and polarization requirements, and the on-orbit spacecraft maneuver, will enable MODIS and MTPE to address key ocean climate questions that are beyond the capability of *in situ* and satellite observing systems presently available. Esaias commended SBRS and MCST for sharing preliminary test results and openly discussing the implications.

Esaias announced that the MOBY II instrumented buoy was deployed off the coast of Lanai, HI, on September 14, 1996. He told the team that the daily network transmission of data to the SeaWiFS Project is underway and so far the data quality is excellent. The MOBY instrumentation is unique in its ability to synthesize the spectral band responses of any ocean color sensor. It will play a role in the initialization of OCTS, SeaWiFS, and MODIS.

Atmosphere Group Discussions

Yoram Kaufman told the Team that all Atmosphere ATBDs have been submitted to the EOS Project Science Office, and all Atmosphere validation viewgraphs are completed. The Atmosphere QA plan is still to be determined—Allen Chu was designated to take the lead on developing that plan, as well as representing the group at the November 6 QA workshop at GSFC. Kaufman announced that the Atmosphere Group prefers MODLAND's definition of a data day—standard GMT. The group also prefers an 8-day temporal grid, in addition to the daily and monthly Level-3 averaging periods.

Kaufman stated that the Atmosphere Group would like to make some software modules available for processing direct broadcast data. He recommended that calibration coefficients and software be made available on the World Wide Web for processing direct broadcast data. He said there is also a need for a software package for visualizing images at Level 1B with latitude and longitude markers.

Regarding interactions with the Data Assimilation Office (DAO), Kaufman said the group feels that the DAO produces a very impressive list of products, and they see the DAO as very responsive to the discipline groups. Thus, the Atmosphere Group plans to work more closely with the DAO in the future. For instance, the group is planning a test of operational NCEP models to run parallel with DAO tests.

Regarding upcoming MODIS thermal vacuum tests, the group recommends characterizing the longwave infrared bands (31 with 32 - 36) crosstalk—both spectral and spatial—using existing data. Kaufman also recommends better characterization of the crosstalk between bands 27 and 5, 6, and 7 with additional thermal vacuum testing.

He encouraged MCST and SBRS to develop a model for the effect of the coating on the scan mirror's infrared properties for both EOS AM and PM MODIS instruments. He also advocates laboratory tests of the mirror for at least the EOS PM instrument.

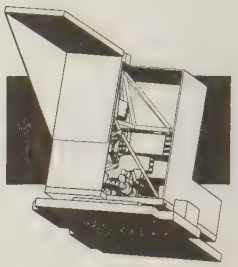
Team Leader's Closing Remarks

Vince Salomonson noted that the MODIS Team has learned of some critical issues facing EOSDIS, and he challenged the team to help EOSDIS evolve so that they can better accommodate all of the EOS science teams.

Salomonson thanked everyone who attended this meeting and announced that the tentative dates for the next meeting are May 13 - 16, 1997.

13th Tropospheric Emission Spectrometer (TES) Science Team Meeting

— **Reinhard Beer** (beer@caesar.jpl.nasa.gov), Jet Propulsion Laboratory



The meeting was held in Pasadena, CA, on October 29-31, 1996. It was scheduled at this time so that the Science Team could have an opportunity to comment on the material to be presented at the System Concept Review (SCR) at Goddard November 12-14, 1996.

The meeting opened with Joe McNeal (NASA HQ) describing the move of many of the MTPE Program Office functions to Goddard, although Joe, himself, remains as the CHEM Platform Scientist and the TES Instrument Scientist. As always, the budget is under pressure (and will continue to be so) but the decision about splitting up the CHEM platform is still under examination (to be resolved about March 1997 under the current schedule).

The JPL Project Manager, Tom Glavich, then provided an overview of the progress on the instrument design over the past year. While the design continues to improve and evolve, a design freeze was imposed in August so that a detailed cost and schedule for the SCR could be prepared. Following the SCR, design work will continue.

The PI, Reinhard Beer, presented the changes to the science requirements, as reflected in the new version (V 5.0) of the Science Requirements document. The major changes that have been made are:

1) to eliminate the "volcano HF" filter, a) because it has been determined that the Signal–to–noise ration (SNR) would be too low to be useful, and b) because the elmination substantially simplifies the signal chain design;

2) to reduce the scan speed by a factor of 2 in order to a) improve the single-scan SNR by 40%, b) halve the data rate, and c) to halve the uncompensated momentum of the interferometer translator mechanism;

3) to restructure the Global Survey mode observation sequences so that each 80-second set contains 2 "embedded" calibrations (cold sky and Black Body), 2 nadir views, and 3 limb views. The sequences will be repeated continuously on a basic 4-day-on-4-day-off cycle, with each 4-day set being preceded and followed by 2 orbits of continuous calibration. The changes were made as a consequence of our experience with the TES aircraft precursor, AES, where we have found that "there is no such thing as too much calibration;" and

4) to decrease the interchangeable foreoptic demagnification from the original 10:1 to 5:1, thereby providing a better match between the limb and nadir footprints.

Most of the rest of the day was given over to the various sub-system groups, introduced by Al Conrad (the recently-appointed TES Instrument Manager at JPL). The intent here was to provide the Science Team both with an overview of the current instrument design and a preview of the material to be presented at the SCR.

The first day concluded with Reinhard Beer presenting a preliminary set of acceptance criteria for the TES instrument. While apparently premature (the instrument does not yet exist!), the criteria are essential to the Integration & Test and Calibration Teams' future planning.

The second day began with Reinhard Beer presenting a first cut at the Standard Product (Global Survey) mode mission timeline, including all calibration sequences. The basic decision has been made to run TES "by the clock," beginning with the ascending node crossing at the beginning of each 4-day cycle. This will greatly ease the development of the flight software.

Most of the rest of the meeting (1-1/2 days) was given over to progress on algorithm development. Levels 1A & 1B are quite well-defined but Level 2 (species retrievals) is still being formulated. Some preliminary segments have been delivered to the software development team but, for example, it is yet to be decided whether the Jacobians should be calculated analytically or by finite differences. Also undecided is the mechanism for determining whether or not convergence has been achieved. However, it was decided that we should attempt to use as much as possible of the prior work by MODIS, MOPITT, and AIRS for cloud detection/clearing and their ATBDs will be carefully studied.

The question of a Level 3 (Mapping) algorithm received considerable discussion. In view of the great progress being made in data assimilation techniques, it was decided that an extensive effort in this area is unwarranted and we shall probably provide no more than a Measurements of Air Pollution from Satellites (MAPS)-type binned browse product, whose development is straightforward (and, above all, can be postponed).

During this period of intensive discussion, relief was offered by Daniel Jacob (Harvard University), who gave an overview of his plans for his recently-accepted Tropospheric Chemistry IDS team and by David Rider (JPL), who described progress on analysis of AES data from the 1995 Southern Oxidants Study (SOS) Nashville-Middle Tennessee Intensive Campaign and plans for the forthcoming (Nov - Dec 1996) deployment on the DC–8 as a secondary experiment on the AirSAR Pacific Rim Experiment. During the ferry flights, we shall obtain numerous spectra of many different types of clouds and (we hope) some clear-sky over-the-ocean data. In concert with TIMS (Thermal Infrared Mapping Spectrometer, an ASTER precursor), we shall also attempt to obtain spectra of volcanic plumes from Pu'u O'o, Hawaii, and White Island, New Zealand.

We wish to record our appreciation of Patricia Mclane (JPL) and her Conference Administration Office for their excellent organization of the meeting.

The next TES Science Team meeting will be held at Harvard University, provisionally, June 11-13, 1997.

Excerpts from
RELEASE: 96-243

Ingenuity Enables NASA Scatterometer To Study Ice, Rainforests

— **Douglas Isbell**, Headquarters, Washington, DC (Phone: 202/358-1753)
— **Mary Hardin**, Jet Propulsion Laboratory, Pasadena, CA (Phone: 818/354-5011)
— **Hideo Hasegawa/Hiroyuki Ikenono**, National Space Development Agency of Japan, Tokyo (Phone: 81-3-5470-4127)

Recent images produced from the NASA Scatterometer (NSCAT) are giving scientists new insight into the Antarctic ice sheet and the Amazon rainforest, after researchers devised ways of using the ocean-monitoring instrument to study land and ice.

The scatterometer's primary function is to study winds over the oceans. A scientist at Brigham Young University (BYU), Provo, UT, however, has developed a way of enhancing the resolution of the instrument's radar backscatter to take a detailed look at land and ice surfaces as well.

"A radar scatterometer measures the radar backscattering cross-section of the Earth's surface. Measurements of the backscatter over the ocean are used to infer the near-surface wind speed and direction, but also can be used over land to study ice and vegetation," said Dr. David Long, an NSCAT team member at BYU. "Areas which reflect more microwaves are typically rougher and appear brighter in the images than smoother areas, which reflect less. The electrical properties of the surface also affect the image brightness. This is the first time we've been able to provide rapid, global coverage that is both uniform and accurate at this resolution."

The polar regions play a central role in regulating global climate, and it is important to accurately

(Continued on page 33)

Landsat Science Team Holds First Meeting

— **Darrel Williams** (Darrel.Williams@gsfc.nasa.gov), Landsat Project Scientist, Goddard Space Flight Center

The first meeting of the new Landsat Science Team was held October 15-17, 1996, in Greenbelt, Maryland. Membership of the Team, chaired by Team Leader, Sam Goward (Department of Geography, University of Maryland), was announced last summer by NASA Headquarters following a full and open competition based on proposals submitted in response to NASA Research Announcement NRA-95-MTPE-03. Team membership is summarized at the end of this report.

NASA, as part of Landsat Program Management (with NOAA and USGS), is managing the development and launch of Landsat 7 through the EOS Program. The ETM+, the only instrument on Landsat 7, is now an integral part of EOS. Because the Landsat Program was authorized by a specific act of Congress (PL102-555) and the stated, primary purpose of the program, maintenance of Landsat data continuity, differs from the goals of the other EOS instruments, the responsibilities of the Landsat Science Team members are complementary to those of other EOS scientists.

In welcoming remarks, Ghassam Asrar, the EOS Program Scientist, told the new Landsat Science Team members that their responsibility is to help clarify the role of Landsat science vis-a-vis the NASA science program. He added that the group should consider and comment on such key issues as access to data, performance of new systems (space and ground), the interaction of spatial, spectral, and temporal measurements, and the synergism of ETM+ measurements with those of other EOS instruments. He noted that NASA's Office of Mission to Planet Earth (MTPE) recently had been delegated responsibility for the Lewis and Clark instruments, and that the Landsat Science Team should consider evaluation of the data from those instruments in light of potential future requirements for hyperspectral measurements.

Tony Janetos, the Landsat Program Scientist, concurred with Asrar's assessment that ETM+ data were crucial for validation of the measurements from other EOS instruments. He added that ETM+ was unique in the EOS program because the data were of known utility to a broad range of users outside the science community. The challenge to the science team was to help plan the evolution of ETM+ technology through identification of requirements for follow-on sensors that would address the needs of science and other Landsat-type data users.

These remarks echoed the charge given the Team by Goward in his welcoming statement as the Landsat Science Team Leader. Goward stressed the 24-year heritage of Landsat and the responsibility of the science community to all Landsat data users. He added that the team should consider focusing on two key topics—the capabilities of the next-generation Landsat, and the evolution of Earth observation from space with respect to the community at large.

These issues were presented in the context of the charter for the Team. A draft of the charter was distributed to the group members for review and written comment. The draft charter identifies the responsibilities for the Landsat Science Team as: 1) to conduct and publish the research described in the proposals submitted by the members, research that incorporates Landsat data into the EOS scientific mission; and 2) to "...offer informed advice and recommendations to the U.S. Government agencies responsible for operating the Landsat 7 system and for defining, developing, and operating follow-on Landsat systems."

On the final day of the meeting, the Science Team accepted Goward's recommendation to write a Landsat science program plan providing a concise, directed statement of the importance of Landsat-type data to the science community and continuation of the Landsat Program following Landsat 7. All members of the Science Team were asked to submit a brief (1-2 paragraph) science justification for Landsat. Specific topics for the report were discussed, and group members were assigned to write on each. The plan will

include an evaluation of the potential for interoperability of Landsat with other systems currently in orbit or planned for launch within the next five years, that provide, or will provide, Landsat-type data., e.g., SPOT and the Indian Remote Sensing Satellite (IRS). Other topics addressed in the science plan will be instrument and platform characteristics, operational configuration, user access to data, exploitation of the historical archive of data and imagery, development of applications and other societal links to Landsat-type data, future instrument design options and the role of Landsat-type data in education.

A schedule for input to the science plan from the team members was established that will lead to completion of the draft plan by April, 1997. The quick action was deemed necessary to have an effect on a congressionally mandated report on recommendations for a Landsat 7 follow-on that will be prepared by Landsat Program Management and submitted to Congress by October, 1997.

Team members were solicited for comments on an acquisition plan for Landsat 7 data presented by Goward. In their comments, the team members were asked to consider the limitations of the system, the overall goal of the Landsat 7 mission, and requirements of non-science users. Comments were requested as soon as possible because the mission data acquisition strategy for Landsat 7 at the U.S. ground station(s) is currently under development. The team also selected members, identified below in the Team membership list, to collaborate with the EOS instrument teams and with the DAAC at the EROS Data Center (EDC). A subteam was formed to review the linkage between ground and instrument calibration.

During the course of the meeting, the Science Team heard reports on the status of Landsat 7 (on schedule for a mid-May, 1998 launch) and the Landsat Program. Materials on all elements of the Landsat 7 project (spacecraft, instrument, and ground system) were presented. Darrel Williams, Landsat Project Scientist at the Goddard Space Flight Center, also summarized the "successes" and "failures" of the Landsat Project Science Office relative to implementing the directives coming out of the *ad hoc* Landsat Science Working Group meetings that were held in 1992 through early 1994. Jim Ellickson of the NOAA/NESDIS Landsat Commercialization Division then presented a summary of the status of Landsat 4 and 5. Ed Sheffner of Ames Research Center, who has been supporting NASA in regard to the Landsat Advisory Process, presented a paper which gave a brief history of the Landsat program and described legislation affecting Landsat and the U.S. land remote sensing program that was introduced in Congress last year. Each Team member also presented a short summary of the research proposed in response to the NRA.

Three action items for all Team members emerged from the meeting—comments on the draft charter; recommendations on the draft acquisition plan for Landsat 7; and contributions to the Landsat science plan. The next meeting of the Landsat Science Team is scheduled for April 15-17, 1997, at the Lockheed-Martin facility in Valley Forge, Pennsylvania. The agenda will include a technical briefing on Landsat 7, a review of the draft science plan, a discussion on "Landsat 8," and other topics to be determined.

More information on the Landsat Science Team is available through the Landsat Program homepage: http://geo.arc.nasa.gov/sge/landsat/landsat.html. Mail may be directed to Science Team Leader: Sam Goward at sg21@umail.umd.edu; a "cc:" copy to Darrel Williams, Landsat Project Scientist, would also be appreciated at Darrel.Williams@gsfc.nasa.gov.

Landsat Science Team members:

Robert Bindschadler	NASA/Goddard Space Flight Center
Robert Cahalan**	NASA/Goddard Space Flight Center
Kendall Carder ***	University of South Florida
Frank Muller-Karger	University of South Florida
Luke Flynn	University of Hawaii
Alex Goetz***	University of Colorado
Samuel Goward	University of Maryland
Susan Moran	U.S. Dept. of Agriculture
Frank Palluconi*	Jet Propulsion Laboratory
John Price**	U.S. Dept. of Agriculture (retired)
John Schott	Rochester Institute of Technology
David Skole	University of New Hampshire
Kurtis Thome*	University of Arizona
James Vogelmann	USGS EROS Data Center
Curtis Woodcock**	Boston University

EOS instrument collaborations:
*ASTER **MODIS ***MISR

EOSDIS Radiation Budget, Clouds, Aerosols, and Tropospheric Chemistry Data

— **John Olson** (olson@magician.larc.nasa.gov), Langley Distributed Active Archive Center, NASA Langley Research Center

The Langley Distributed Active Archive Center announces the availability of the free Earth Radiation Budget Experiment (ERBE) CD-ROM. The CD-ROM is ISO9660 compliant allowing PCs, Macintoshes, and Unix machines to access it. The CD-ROM contains monthly scanner data and color images from scanning radiometers on the three ERBE satellites and for combined satellite cases. The data are provided in text format and the color images in GIF format. The data are averaged values on a 2.5 degree by 2.5 degree equal-angle grid. There are data for the period November 1984 to February 1990. Each data file contains clear-sky and all-sky values for shortwave radiation, longwave radiation, albedo, and net radiation as well as longwave cloud forcing, shortwave cloud forcing, and net cloud forcing.

This CD-ROM may be ordered from the Langley DAAC home page at http://eosdis.larc.nasa.gov/ by following the "Access Data" link to the Order Form for CD-ROMs and Videocassettes. More information may be obtained from the Langley DAAC Science, User, and Data Services Office at larc@eos.nasa.gov.

The Langley Distributed Active Archive Center, located in Hampton, Virginia, is responsible for the archival and distribution of NASA science data in the areas of radiation budget, clouds, aerosols, and tropospheric chemistry. The Langley DAAC will also archiving some of the data sets which result from the EOS program and other elements of Mission to Planet Earth. Currently archived and available for distribution are data from the Earth Radiation Budget Experiment (ERBE), the International Satellite Cloud Climatology Project (ISCCP), the Stratospheric Aerosol and Gas Experiment (SAGE), the Surface Radiation Budget (SRB), the First ISCCP Regional Experiment (FIRE), the Global Tropospheric Experiment (GTE), and the Stratospheric Aerosol Measurement (SAM) II. These data products are free of charge.

The Langley DAAC has developed an on-line computer system which allows users to logon, search through the DAAC's data inventory, choose desired data sets, and place an order. Data may be received either electronically (via ftp) or on media such as 4 mm tape, 8 mm tape, or CD-ROM (prepackaged data sets only). To access follow the "Langley DAAC Order System" link.

For users without x-windows, the new Version 0 WWW Gateway is available. This gateway allows a user to use a WWW browser to search the EOSDIS holdings and order data. Follow the "Multi-DAAC Ordering System (V0 IMS)" to the Version 0 WWW Gateway link.

Orders for prepackaged products available from the Langley DAAC may be placed through the order form for CD-ROMs and videocassettes. This form is reached through the "Order Form for CD-ROMs and Videocassettes" link.

The new ISCCP D products being archived at the Langley DAAC may be ordered from the Langley DAAC home page as well. Follow the link "Data Accessible from the Web." From this page, media and ftp orders for the ISCCP D Products can be made.

For information regarding Langley DAAC data or to place an order, please contact:

Langley DAAC Science, User, and Data Support Office
NASA Langley Research Center
Mail Stop 157D
Hampton, VA 23681-0001
Tel: (757) 864-8656; Fax: (757) 864-8807
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Land Processes DAAC Science Advisory Panel Meets at EDC

— **Bryan Bailey** (G.=Bryan=Bailey%ssb%EDC@edcserver1.cr.usgs.gov), EROS Data Center, Sioux Falls, SD 57198

The Land Processes DAAC Science Advisory Panel held a regular meeting at the USGS EROS Data Center (EDC) on November 5-7, 1996. Attending were a quorum of Panel members and alternate members, as well as meeting participants and interested observers from EDC, NASA, and EOSDIS Core System (ECS) contractor, Hughes Information Technology Systems (HITS).

Land Processes DAAC Project Scientist and Panel Co-Chair, Bryan Bailey, opened the meeting by reviewing the meeting agenda, as well as highlights of the last Panel meeting. Bailey also noted that points of emphasis for the present meeting would include EOSDIS replan activities, 1997 DAAC activities, and setting DAAC priorities. Panel members and DAAC staff reviewed outstanding action items from the last meeting, including the status of letters addressing the role of international ground stations in the Landsat 7 data acquisition strategy, an ASTER Level 1 expedited data system at the Land Processes DAAC, and concerns about potential budgetary impacts of free data.

John Daucsavage, Land Processes DAAC ECS Engineering Liaison, presented operations plan overviews for ASTER, MODIS, and Landsat 7. He did this in the context of: 1) flow of command generation; 2) flow of pre-DAAC science data processing; and 3) flow for the Land Processes DAAC and user interface for each of the three sensors.

John Dalton presented the Panel with information on the EOSDIS Replan. He stressed that the details are not final, and that replanning includes input from the stakeholders. He pointed out that the ECS science data processing segment is currently projected to slip from December 1996 to May 1997 for Release A TRMM. The impacts on AM-1/Landsat-7 Release B are being analyzed, and the Replan is to be completed by mid-December. He stated that flight operations segments and EDOS are on schedule to support AM-1, and that replanning assumes continued support of MTPE launch schedules. Factors contributing to the slip were underestimation of code size at CDR, COTS software incompatibilities across vendor platforms, difficulty in recruiting and retaining expertise in key technologies, and the discovery that planned recovery through parallel development is not feasible due to serial dependencies.

Dalton's presentation precipitated discussion on a variety of issues. The Panel expressed concern about potential negative impacts on the DAAC resulting from slips in EOSDIS schedules. Panel members are particularly concerned about the apparent lack of subsetting capabilities being planned for B.0, and they are concerned about the lack of capabilities to conduct Science Software Integration and Test (SSI&T) at Release A. The Landsat 7 Project and the DAAC took actions to further address these issues.

The Panel again discussed the data pricing policy for DAAC data, which is an issue about which it previously had expressed concern. While the Panel strongly supports broad distribution of data and products, it is concerned that "no cost" data encourage the non-serious user to order large volumes of data and products simply because they are free. As a result, an undue burden is placed on DAAC resources, and service to the serious user is negatively impacted. Some (small) cost may need to be charged for data and products to discourage frivolous use.

Instrument Team updates were presented by Panel members representing ASTER, MODIS, and Landsat 7, and a summary of recent SAR-related activities also was presented. In addition, DAAC staff reported on specific DAAC-MODIS and DAAC-ASTER activities of particular interest that have occurred since the last Panel meeting. Notably, an updated land/sea mask produced from the World Vector Shoreline and Digital Chart of the World data sets has been completed, and Requests for Quotations for the ASTER DEM standard data product generation software have been distrib-

uted, with recommendations for award anticipated by mid-February.

The second day of the meeting was devoted largely to review of DAAC activities, discussion of FY 1997 plans, and prioritizing future activities. DAAC staff made presentations on 1996 data distribution statistics, DAAC user services status and plans, the DAAC's "integrated" (ECS and non-ECS) staffing plan for the at-launch time frame, and the DAAC's Topographic Data Sets Project, including announcement that the Global 1-km DEM Data Set has been completed and is available via ftp from the DAAC. The data set, which has been named GTOPO30, soon will be available on CD-ROM.

DAAC Manager, Lyn Oleson, presented an overview of the FY 1997 DAAC Work Plan covering non-ECS AM-1 and ongoing activities. His presentation focused largely on the proposed FY 1997 budget both in the context of ESDIS guidance and the following categories of DAAC activities: DAAC management, engineering and development, data set acquisition and ingest, mission support, and data and information services. Oleson's presentation led to considerable discussion, including debate over what relative emphasis should be placed on ingesting data sets into the IMS versus making them accessible via web pages. The Panel concluded that because the IMS will be the user interface for EOS data, emphasis must be placed on populating the IMS. Earlier, the Panel had encouraged the DAAC to strongly resist accepting additional data sets without accompanying funding and available personnel resources to take on the data set, and to ensure that there is little or no negative impact on its "at-launch readiness" from accepting additional data sets. During this discussion, the Panel readdressed the topic of what data sets should be brought into the DAAC and under what conditions. It requested the DAAC to confer with NASA in developing a policy, including criteria and funding options, for bringing new, non-EOS data sets into the DAAC. Finally, the Panel offered a few specific recommendations on the proposed DAAC budget.

The final morning of the meeting was devoted largely to summation and action item review. Current Panel Co-Chair, Tony England, has asked to step down from that position due to time constraints. The Panel accepted Tony's request and expressed gratitude for his service. The Panel appointed Chris Justice to serve as new Co-Chair. Justice led a discussion that attempted to assess the relationship between the DAAC and its Science Advisory Panel. Those aspects that have worked well were noted, as were areas where improvement would benefit the DAAC in its efforts to meet the needs of the land science community. Specific ideas for facilitating needed improvement were offered.

The next meeting of the Land Processes DAAC Science Advisory Panel will be held in April, 1997.

Announcement

Global Warming and Climate Change Brochure

— **Joe Schumacher** (jschumac@ciesin.org),
U. S. Global Change Research Information Office,
2250 Pierce Road, University Center, MI 48710

The U.S. Global Change Research Information Office (GCRIO) is pleased to announce the online availability of *Global Warming and Climate Change*, a publication prepared by researchers in the Department of Engineering and Public Policy at Carnegie Mellon University to explain the issue of global warming and climate change to a general audience. Issues addressed include: the science of global warming; the potential impacts of climate change, and the range of policy responses to the threat of climate change.

Global Warming and Climate Change can be found on the WWW at: http://www.gcrio.org/gwcc/toc.html.

National Snow and Ice Data Center (NSIDC) User Working Group Meeting

— **Konrad Steffen** and **Ronald Weaver** (weaver@kryos.colorado.edu), National Snow and Ice Data Center, University of Colorado at Boulder

INTRODUCTION

On November 4-5, the User Working Group for the National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center (DAAC) met in Boulder, Colorado. The following briefly recounts the discussions held and recommendations offered to the NSIDC DAAC.

Research Announcements, Bob Thomas, NASA HQ: NASA is moving towards fixed deadlines for research proposal submissions. A coordinated Sea Ice Research Announcement (RA) will be published in Spring '97 for funding in '98, and an Ice Sheet RA is planned to be released in Summer '97 for funding in '98. The science oversight and the budget control for the five Polar Pathfinders will be moved from GSFC to NASA Headquarters, under Thoma's leadership.

NSIDC Update, Roger Barry: DAAC activity highlights of the past six months include the following accomplishments: SSM/I Polar Stereo Grid Tb's and ice concentrations have been processed and distributed through September, 1995; an SSM/I sea ice products team has been formed (J. Maslanik, J. Stroeve, Li); SMMR Ta's and Tb's have been transferred from the MSFC DAAC to the NSIDC DAAC; a total of 15,600 polar AVHRR scenes has been processed and archived and DOMSAT data ingest for AVHRR 1 km data is now active. The DAAC Yearbook has been produced and distributed, and five new hires have been brought aboard: for data coordination (A. Nolin, T. Zhang), for the sea ice product team (J. Stroeve, X. Li), and an ECS System Engineer (L. Head, Hughes employee). The user request statistics showed a slight decrease in '96 (1385) compared to '95 (1500), but a total of 822 new users was registered.

New Mission Data Coordinators: As mentioned in the update report, NSIDC has hired two Ph.D.–level scientists to augment the DAAC's capability to interface to Instrument Teams and to service data sets and products. Anne Nolin will coordinate data products at NSIDC for the planned MTPE missions, MISR and GLAS, and related altimetry data. Her science interests are in dynamic albedo changes, snow energy/mass balance modeling, modeling the snow bidirectional reflectance distribution function (BRDF), and snow cover mapping at sub-pixel resolution. Tingjun Zhang will coordinate land-based *in situ* data and validation efforts at NSIDC. His science interests are in Arctic climate change, snow, ice, and permafrost, and heat and mass transfer in porous media.

Alaska SAR Facility Update, Kim Partington: ASF user services will be enhanced (new position). No data have been delivered in the 3rd quarter of CY 96 due to major problems with the system upgrade. JERS-1 data have been processed and delivered; ERS-1/2 data will be processed later this month. RADARSAT uncalibrated data will be distributed on request to the Applications Development and Research Opportunity (ADRO) project PIs in December. RADARSAT SCAN SAR B data will be calibrated first, and processing and distribution are scheduled for April 1, 1997.

Cryospheric Working Group, Barry Goodison: The cryospheric chapter of the EOS Science Plan was discussed and a revised outline presented. Several experiments need to be added to the chapter (8.3.2) on surface observations and field experiments (e.g., PARCA (see below), WAIS, others?). The final deadline for this chapter is November 30, 1996. Further, the Chair of the Cryospheric Working Group is still vacant. The Polar DAAC Advisory Group (PoDAG) has

agreed to coordinate and chair the Cryospheric Working Group until a new chair has been found. See http://www-nsidc.colorado.edu/NASA/CRYOSPHERIC_CHAPTER.

SSM/I Polar Stereo Grid Processing, Jim Maslanik: SSM/I brightness temperatures for F8 and F11 have been distributed on CD-ROMs. F13 SSM/I Tb's (May '95 - June '96) will be distributed on CD by December 1, 1996. A new enhanced ice concentration CD series with F8, F11, and F13 with NASA Team- and Bootstrap-derived values is scheduled for February 1, 1997. Quality control issues were discussed, such as weather effects, land contamination, and data set consistency.

Workshop on Sea Ice Observations, Ron Weaver, Koni Steffen: New techniques will be tested and implemented in the coming 4-5 years that supersede the current algorithms, offering greater accuracy and resolution. Existing empirically-based passive microwave sea ice algorithms can be improved by incorporating new methods which exploit the full spectrum of remote-sensing data and modeling (data assimilation). The proposal was made to organize a workshop at NSIDC to promote new ideas for the study of the Arctic sea ice cover. The PoDAG members proposed selecting a workshop organization committee and discussing possible agenda items. The workshop would be held no sooner than December 1997.

SMMR Pathfinder vs. GSFC Tb's, Ron Weaver: The Pathfinder and GSFC SMMR Tb histograms gave the following differences: 2 K (37V), 5 K (18H), and 3.5 K (18V). There were some pixels with differences above 10 K. The largest differences were found over open ocean; the smallest differences over sea ice. This suggests that the differences arise from different ocean radiative transfer models used by Per Gloerson (GSFC) and Eni Njoku (JPL). PoDAG proposed looking for the cause of this difference in more detail.

SSM/I F11 and F13 Intercomparison, Julienne Stroeve: For the months of July, August, and September 1995, a common data set for two different SSM/I instruments (F11 & F13) is available. The equator crossing time for F11 is 6:25 p.m., and for F13, 5:43 p.m. The intercomparison of brightness temperatures was done for regions over the Greenland and Antarctic ice sheets, and for sea ice regions in the Arctic and Antarctic. The F11 and F13 data sets are highly correlated, with best correlation for the Antarctic ice sheet, and least correlation for the Arctic sea ice region. Using *ice sheet* coefficients, slight regional biases remained, and larger discrepancies in multi-year ice concentration resulted. Using *sea ice* coefficients, the regional sea ice biases were eliminated, but larger weather effects were obvious. Without adjustments, the F11 and F13 sea ice extent and total sea ice area agree within 2%. Currently, the NSIDC F11-derived sea ice products incorporate the regression coefficients of Abdalati *et al.*, based on an intercomparison of F8 and F11 (December time period) over the Greenland ice sheet. PoDAG proposed to use globally-derived coefficients, employing techniques developed by F. Wentz.

HDF Format Survey, Claire Hanson: The survey was sent to 618 users, and 74 responses were received (12% response rate). About 70% of users are using commercial software, and 30% are using freeware to display HDF format data. In general, 55% of the users have an overall positive experience with the HDF format, 14% reported a negative experience, and 31% had no opinion. Most of the PC and MAC users recommended the development of the EOS View Tool, which currently is only planned for UNIX systems. NSIDC made tools available for HDF conversion on the NSIDC ftp site.

GLIMS, Bruce Raup: The Global Land Ice Monitoring from Space (GLIMS) project proposes to monitor most glaciers and ice sheet margins on Earth once a year throughout the lifetime of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). The amount of ASTER data required annually for GLIMS glacier monitoring is only 1.5% of the collected ASTER Level 1A, but still accounts for 82 Gbytes/year. The anticipated GLIMS database of 550 Mbytes will consist of 10 variables from 100,000 glaciers over a 5-year period. The resulting data set will be archived at the NSIDC DAAC. The GLIMS coordination center resides at USGS in Flagstaff, whereas most of the data processing will be done at the regional centers all over the globe. See http://wwwflag.wr.usgs.gov/GLIMS/glimshome.html.

Coordination of Polar Pathfinder, Axel Schweiger: The purpose of this coordination effort is to maximize the scientific value of the polar Pathfinder data sets by making them easy to use in combination. The participating Pathfinder projects are TOVS, SSM/I-SMMR

Ice, AVHRR, and SSM/I-SMMR Atmosphere. A common multi-resolution grid structure has been defined with standardized file names, variable names, and file formats. Further, a common data set has been proposed (P-CUBE), with 100-km resolution containing most relevant variables from all data sets. See http://www-nsidc.colorado.edu/NASA/POLAR_PATHFINDER.

POLES Update, Drew Rothrock: The Polar Exchange at the Sea Surface (POLES) interdisciplinary investigation studies the lower troposphere, the sea ice cover, and the high-latitude oceans. Intercomparisons of different cloud and radiative flux density data sets reveal large discrepancies of up to 0.25 cloud fraction, and 50 W/m^2 flux density, respectively, independent of season. However, the flux density needs to be known with a mean monthly rms error of less than 10 W/m^2 during winter for sea ice modeling. The POLES cloud detection and masking algorithm was quoted with an accuracy of 0.15 cloud fraction during winter. Further, comparison between individual observations of flux densities and coincident AVHRR-derived flux values for downwelling shortwave radiative flux showed good correlation (0.99), with -4.2 W/m^2 bias, and rms error of 32 W/m^2. A similar comparison was done for longwave radiative flux from TOVS data, showing a bias of -3 W/m^2, and standard deviation of 23 W/m^2. See http://psc.apl.washington.edu/poles/.

RGPS Update, Drew Rothrock, Kim Partington: The RADARSAT Geophysical Processor System (RGPS) is using ScanSAR B data to derive ice products once a week for the entire Arctic. Data acquisition started on October 24, 1996. The five data products from RGPS on a weekly 5-km grid will comprise 2-3 Gbytes per year. See http://psc.apl.washington.edu/RGPS/.

CRYSYS Update, Barry Goodison: The Cryospheric System (CRYSYS) to Monitor Global Change in Canada involves over 30 active participants from government and universities. The scientific goals of CRYSYS are: to develop capabilities for monitoring and understanding variations in cryospheric processes (regional to global scale); to develop and validate climate processes and dynamics; and to analyze various data sets (historical, operational, and research) for climate monitoring and model validation. Several time series were discussed: arctic sea ice concentration derived from passive microwave; ice and snow thickness variations from observations and modeling (Resolute Bay, NWT); and snow water equivalent derived from airborne microwave measurements.

K-12 Outreach, Alex Weaver: Basic problems with K-12 outreach are that teachers have very little time and money, that many (especially K-6) have only a limited science background, and that they need current science content and guidance in using it in the classroom. Although individual PoDAG researchers make excellent contributions to the K-12 community, there is little funding for a coordinated effort by NSIDC, for example. NSIDC User Services currently limit their K-12 outreach work, because staff and resources are not available for a more extensive effort. Worthwhile projects (like the partially completed "Avalanches" resource) are postponed indefinitely because of the lack of staff time and funding. Some suggestions on how to improve the outreach were: continue to support national-scale projects, e.g., CIESIN; provide teachers' workshops to support the use of the "Sea Ice in the Polar Regions/Arctic Observatory" CD-ROM; encourage improvements in NASA curriculum materials, e.g., prepare new lithograph on Polar Ice; revise activities on the Sea Surface Temperature lithograph; and revise the Polar Ice Fact Sheet. It is important that funding agencies recognize these needs and provide long-term support for K-12 activities.

Landsat 7 Polar Application, Ted Scambos: Recently, a grant was funded to map changes in the Antarctic using Landsat imagery. A main objective will be to map the outflow velocities in West Antarctica, using a cross-correlation feature-mapping algorithm. The MTPE project will be accomplished over the course of three years. Financial support of $20,000/year was requested for a data specialist to convert the derived ice motion data. The data would than be made available to the polar community through the NSIDC DAAC.

SSM/I Snow Melt Product, Mark Anderson: A new passive microwave data product to classify the onset date of snow melt in the Arctic ocean region was presented. The data set will be a valuable addition for the present ice concentration data set, as the ice concentration algorithm performs poorly under snow melting conditions. The NSIDC DAAC was urged to make this low-density data set available to the community.

PARCA Greenland Climate Data Set, Koni Steffen: The Program for Arctic Regional Climate Assessment has deployed a number of automatic weather stations on the Greenland ice sheet. The Greenland Climate Network (GC-Net) will collect data over the next 4 to 5 years from a total of 14 stations, with 500 parameters transmitted hourly via satellite links. It is proposed to archive the original data set at the NSIDC DAAC, and to produce a Greenland climate CD-ROM with GC-Net data and auxiliary data sets from meteorological stations around Greenland. See http://cires.colorado.edu/parca.html.

RECOMMENDATIONS

PoDAG Meetings: Future PoDAG meetings will be held 8 months apart. Important issues will be discussed via telecom when needed. We encourage NSIDC to support sub-group meetings of PoDAG members to resolve urgent action item issues between the PoDAG meetings. The next PoDAG meeting will be in Boulder, in third week of June 1997.

PoDAG Co-Chair: Dave Bromwich agreed to act as Co-Chair of PoDAG during the sabbatical leave of the present chair.

EASE Grid SSM/I CD-ROM Distribution: PoDAG recommended continuing the Equal Area SSM/I Earth (EASE) Grid CD-ROM distribution. However, the community should be questioned if it needs all three data sets (northern Hemisphere, southern Hemisphere, and global). To reduce production cost, users should be asked to be more rigorous with their selection.

Workshop on Sea Ice Data Assimilation: A small working group/organizing committee should meet in the spring to define the goals of the workshop.

SSM/I Polar Stereo Grid Processing: NSIDC should provide a climatological mask to flag weather effects in open ocean areas for daily ice concentration production. For the weekly ice concentrations, two different data sets should be provided: a) derived product with no masking, and b) derived product with climatological mask applied to flag weather effects in open ocean areas.

Landsat 7 Antarctic Data Set: PoDAG did not recommend supporting the financial request for a DAAC-funded data person for this project; however, PoDAG encouraged making the West Antarctic ice motion data set available through the NSIDC DAAC, when the relevant research is completed.

SSM/I Snow Melt Product: PoDAG recommends that the passive microwave snow melt time series produced by Mark Anderson be made available for distribution through the NSIDC DAAC.

ACTION ITEMS

SMMR Pathfinder vs. GSFC SMMR Tb's, J. Stroeve: Compare radiative transfer code for Pathfinder and GSFC SMMR data processing. Try to evaluate if the Tb difference for the two data sets is the result of different coding. Get community expertise if required. Report findings by February '97.

Polar Pathfinder Common Tools, R. Weaver: The Polar Pathfinder group proposed a common tool to access their data: (e.g., variables, region, dates, resolution). NSIDC should provide a cost estimate to develop this tool, assuming that the Pathfinder group would provide their data in a common data format which is accessible for the tool.

SSM/I F11 and F13 Intercomparison, J. Maslanik: Contact F. Wentz to learn when the global F11 vs. F13 intercomparison, coefficients will become available. Work an alternative plan to derive these coefficients at NSIDC if timing is crucial. Report on telecom in January 1997.

What's New?

The Mission To Planet Earth/Earth Observing System Data Products Handbook — http://eospso.gsfc.nasa.gov/eos_homepage/pubs.html.

Global Learning and Observations to Benefit the Environment (GLOBE) — http://eospso.gsfc.nasa.gov/eos_homepage/education.html.

EOS Investigators Working Group (IWG) Meeting registration form — http://eospso.gsfc.nasa.gov/eosCAL.html.

OCTS Browse Utility Available on SeaWiFS Homepage

— **Gene Feldman** (gene@seawifs.gsfc.nasa.gov), NASA Goddard Space Flight Center, Greenbelt, MD

We are pleased to announce the availability of a web-based browse utility for OCTS data of U.S. coastal waters that are currently being received at Wallops Island and the Alaska SAR Facility. This tool features quasi-true-color images mapped to a global projection, in addition to point-and-click access to the higher resolution (10x10 subsampling) images. These true-color images are intended merely to enable researchers to geographically identify scenes, to determine cloud coverage, and to identify major features of interest that may be visible in true-color images such as these (land features, major ocean color changes, etc.).

The OCTS browse utility is available from the SeaWiFS Homepage at: http://seawifs.gsfc.nasa.gov/SEAWIFS.html or directly at: http://seawifs.gsfc.nasa.gov/seawifs_scripts/octs_browse.pl.

Following are some of the features of the OCTS browse tool. When the screen first appears, a global map of the most current day for which we have received OCTS data is displayed. For most of the current day, a single pass from Alaska might be all you will see. There will also be a small map at the bottom of the page, indicating which stations have provided data for that day (as of the current time). Also on this page, is a hyperlinked calendar showing all the days of the current month for which we have data, and a number in parentheses that indicates the number of orbits we have for that day. Clicking on any of the hyperlinked dates on the calendar will take you to that date, and display the corresponding data files. You can go to any of the previous months by selecting the name of the month in the forms window and pressing the "Set Month" button. Also, you can choose to look at data from only one of the ground stations by selecting the station of interest from the forms window and pressing the "Set Stations" button. As a rule of thumb, the current day's display will generally be somewhat sparsely covered, until late in the afternoon (eastern time). You might wish to look at the previous day's coverage, or pick a day that has a large number of orbits.

If you are looking at the global map of browse products and wish to examine one of the orbits in more detail, just click on the area of interest on the map, and a screen displaying the 10x10 subsampled image will be presented. Many of the orbits will have a tilt change somewhere near the middle of the pass, which is easily seen in the image. Features to look for include the Bahama Banks off the eastern coast of Florida, the Appalachian Mountains, river plumes in the South Atlantic Bight, and many others.

As part of a NASA/NOAA/NASDA collaboration, data received at these two stations, along with selected data recorded on board and transferred from Japan, are currently being archived within the SeaWiFS Project. The SeaWiFS Project looks on this activity as a way to ensure that ocean color data from OCTS is preserved, and as a very good test of the Project's readiness for the launch of SeaWiFS. In fact, we are using this opportunity to incorporate OCTS processing within the existing SeaWiFS data processing system with great success. It is also providing a chance to exercise all facets of the SeaWiFS Project. This activity also represents a wonderful example of interagency cooperation, where NASA, NOAA, and NASDA all contribute expertise and infrastructure to benefit the scientific community.

It must be pointed out, however, that the data being received and stored at the present time are in raw format, and not available for distribution. All data acquired by OCTS are archived at the Earth Observation Research Center in Japan and all requests for data should be directed to them at the present time. They can be reached at: http://mentor.eorc.nasda.go.jp/index.html.

After a hiatus of nearly a decade, it is an absolute pleasure to be able to work with real data once again.

On Sources and Atmospheric Concentrations of Nitrous Oxide

— Reprinted from IGACtivities Newsletter, Issue No. 6, September 1996.
Contributed by **A.F. Bouwman**, National Institute of Public Health and Environment, Netherlands, **C. Kroeze**, Wageningen Institute for Environment and Climate Research, Netherlands, and **J.A. Taylor**, Australian National University

Nitrous oxide (N_2O) is one of the greenhouse gases in the atmosphere whose atmospheric concentration has been increasing since pre-industrial times. Despite many existing uncertainties, several sources of N_2O have been identified. This paper gives a brief overview of the current knowledge on atmospheric concentrations and emissions of N_2O and discusses some aspects of future research.

Although N_2O occurs in the atmosphere in minute quantities compared to CO_2 and water vapor, its contribution to the greenhouse effect is considerable. This is caused by its long residence time in combination with the relatively large energy absorption capacity per molecule. Per unit mass the global warming potential of N_2O is about 310 times greater than that of CO_2. The global annual atmospheric CO_2 increase is about 3000 million ton CO_2-C, primarily from fossil fuels. Although the anual increase of the mass of N_2O in the atmosphere of 4-5 million ton N_2O-N is close to three orders of magnitude smaller than this amount, its contribution to global warming is of the same order of magnitude as that of CO_2.

Nitrous oxide is a long-lived gas because it is inert in the troposphere. However, in the stratosphere N_2O is removed by photolysis and reaction with excited oxygen atoms, $O(^1D)$. The oxidation of N_2O according to the latter reaction yields NO, providing the major input of NO_x to the stratosphere, thus in part regulating stratospheric ozone and influencing the NO_x balance in the upper troposphere (Crutzen, 1970).

Analysis of Antarctic ice core samples indicates that the atmospheric N_2O concentration has risen from about 275 ppbv in pre-industrial times to about 293 ppbv in the beginning of the 20th century and to 311 ppbv now. Records from longer periods indicate that the atmospheric N_2O concentration was at least 30% lower during the last Glacial Maximum than during the Holocene epoch, and that present-day N_2O concentrations are unprecedented in the past 45,000 years (Leuenberger and Siegenthaler, 1992). The atmospheric N_2O concentration started to increase rapidly during this century, but an accelerated increase may have started only after 1940. The observed increase of atmospheric N_2O during the 1980s was 0.25% or 0.8 ppbv per year. However, the trends over the last decade are extremely variable, ranging from 0.5 to 1.2 ppbv per year.

The annual increase of atmospheric N_2O during the 1980s of 0.25% was caused by an imbalance of sources over sinks of 4-5 million ton N_2O-N per year, accounting for 25% or more of the total annual source of 16 million ton N_2O-N. The stratospheric destruction removes 12 million ton N_2O-N per year (Minschwaner *et al.*, 1993). The atmospheric lifetime of N_2O based on the destruction rates and the atmospheric burden amounts to 120 years.

Most of the N_2O in the Earth's atmosphere stems from microbiological processes. In soils and aquatic systems the major sources of N_2O are generally accepted to be denitrification and nitrification. In subsurface environments denitrification is the major source of N_2O. Under reducing conditions with no other available source of N, N_2O may be consumed in soils. Uptake of N_2O by the ocean surface has also been observed. At present the knowledge on the conditions at which soils and aquatic systems act as sinks for N_2O, and the parameters affecting the influx when they do so, is too limited to evaluate their importance at the global scale.

Although in recent years considerable progress has been made in the identification of source candidates, the uncertainty in the various source estimates has not been reduced. The N_2O emissions from fossil fuel combustion and biomass burning had long been considered the major cause of the atmospheric increase. This view changed in 1988 when it was discovered that in mixtures of flue gases (such as in power plant effluent), that are stored in stainless steel canisters even during short periods, reactions occur in the

presence of SO_2, NO_x, and H_2O that can produce substantial amounts of N_2O. All past work on N_2O from coal combustion had relied on stored samples and became suspect. Now it is accepted that direct N_2O emission from stationary fossil fuel combustion contributes less than 1% of the global source. However, as yet unknown amounts of N_2O may be formed in smoke plumes resulting from biomass burning, in exhaust gases from other combustion processes, and during catalytic reduction of NO_x.

The recent history of global "budgets" of emissions of N_2O illustrates the change in views before and after the discovery of the sampling artifact (see table). A great number of source candidates have been identified, including fertilized agricultural soils, livestock production systems, soils under natural vegetation, aquatic sources, biomass burning, land use changes, fossil fuel combustion, automobiles, industrial, and other sources.

The major sources in most N_2O budgets are formed by soils under natural vegetation, followed by oceans. Despite the uncertainty in the global N_2O budget, the most recent IPCC assessment indicates that agricultural activities are the most important anthropogenic source of N_2O (IPCC, 1995). The increase in the use of catalytic converters in cars, which cause much higher N_2O emissions than cars not equipped with catalysts, may lead to an important increase in emissions in the future. Atmospheric oxidation of ammonia (NH_3) to N_2O by hydroxyl radicals (OH) may be an important and increasing source.

There are a great number of poorly known, minor sources of N_2O, such as lightning and corona processes around high-voltage electrical transmission lines. Recently, global warming has also been mentioned as a potential N_2O source (see table). Other minor sources not listed in the table include fresh water and coastal marine waters, effects of N deposition on soil N_2O emission, the production and use of explosives, medical and industrial use of N_2O, and use of N_2O as an aerosol propellant.

Current global estimates of emissions and atmospheric removal do not account for other possible removal processes, such as uptake of N_2O by soils and aquatic ecosystems, and the potential role of the oceans as a reservoir of N_2O. If sinks of N_2O turn out to be important, the source estimates need to be revised as well to obtain the correct increase in N_2O concentration.

It is difficult to quantitatively determine biogenic fluxes of N_2O. This is caused by the extreme temporal and spatial variability of the processes of N_2O formation and exchange in all biogenic sources. In addition, in early studies a few representative measurements were used to extrapolate to the global flux. Nowadays, more attention is paid to techniques of scaling. For example, terrestrial ecosystems should be stratified by delineation of functional types on the basis of soil, vegetation, and terrain characteristics. Remote-sensing observations are increasingly used for delineating. Similarly, functional groupings can be made in oceans on the occurrence of upwelling, temperature, concentrations of nitrous oxide, nitrate, oxygen, and organic matter. For biomass burning the type of fuel and fire intensity can be used as a basis for scaling.

Functional types can form the basis for measurement schemes, so that the variability within delineations is reduced compared to that of the whole system. Mi-

Global N_2O budgets presented between 1984 and 1994. Source estimates in million ton N_2O–N/year.

Source	Year		
	1984[a]	1986[b]	1994[c]
Soils under natural vegetation	2.6-25	3.5-11.5	3.3-9.7
Agricultural soils	1.6-5.3	12-14	1.8-5.3
Animal excreta (cattle and feedlots)			0.2-0.5
Biomass burning	1-2	0.5-0.9	0.2-1
Land use changes			0.2-0.6
Oceans	1-10	1-3	1-5
Fossil fuels; stationary combustion	1-2	3-5	0.1-0.3
Fossil fuels; mobile combustion			0.1-0.6
Industry			0.5-0.9
Aquifers			0.5-1.3
Sewage & waste water treatment	1-2		0.2-1.9
Global warming			0-0.6
Atmospheric chemistry, lightning, corona processes	0-21		0.3-1.2
Total	9-67	9-22	10-17

[a] Banin et al. (1984)
[b] McElroy and Wofsy (1986)
[c] IPCC 1994/1995 assessment and other literature

crometeorological (e.g., eddy correlation and eddy accumulation techniques) and remote sensing techniques are used to determine fluxes for larger areas. The traditional enclosure methods, whereby the fluxes are determined from the concentration change within a flux chamber, are still needed to study the processes and their regulating factors and to develop process models to simulate fluxes. With appropriate techniques for integrating knowledge acquired at a detailed scale towards larger scale levels, and validation of the results against measurements at higher scale levels, fluxes can be extrapolated. Hence, scaling not only involves bottom-up methods, but also top-down approaches. At the global and regional scale a promising technique is inverse modeling, whereby atmospheric concentrations are used to calculate backwards where the source regions are, and to determine the fluxes from these regions. Inverse modeling of N_2O is hampered by the small number of long-term monitoring stations. At present N_2O records are available from 10 monitoring stations of the Atmospheric Lifetime Experiment-Global Atmospheric Gases Experiment (ALE-GAGE) and NOAA Climate Monitoring and Diagnostics Laboratory (CMDL) networks. Most of these stations are located in remote places away from major source regions, where air is thoroughly mixed, to establish global trends in concentrations. For atmospheric modeling the global coverage may not be adequate, because signals from continental sources are not recorded.

Isotopic ratios of stable isotopes are a very promising tool in top-down scaling (see, e.g., Kim and Craig, 1993). The $^{18}O/^{16}O$ isotopic ratios of N_2O can be sensitively measured, and $\delta^{18}O$ values for N_2O derived from nitrification are lower than those for N_2O from denitrification. Assuming that these isotopic differences are uniform among different systems, the process of formation of N_2O may be determined. Nitrous oxide in soil and groundwater may be significantly depleted in ^{15}N and ^{18}O relative to tropospheric N_2O. In surface ocean waters down to 600-m depth, N_2O is depleted in both heavy isotopes, but at greater depth N_2O is enriched in ^{15}N and ^{18}O. Coal plant and engine exhaust have been shown to be enriched in ^{18}O relative to N_2O in the troposphere and in soil and groundwater. The N_2O from the stratospheric backflux to the troposphere may be heavier than tropospheric N_2O. However, more determinations of the isotopic ratios of N_2O in the atmosphere are needed to identify and quantify N_2O sources.

There are several options to reduce emissions of N_2O. If current trends continue, global emissions may increase by 4-13 million ton N_2O-N per year during the next century. Some of this increase can be avoided. Most importantly, emissions related to industry and stationary combustion can be reduced. In agriculture a reduction of N_2O emission per hectare seems feasible in several world regions. A fast increase in food production and increasing importance of animal production is expected in the coming decades, caused by fast population increase and economic growth in large parts of the world. In addition, an increase in the number of cars equipped with catalytic converters is envisaged. These developments may lead to significant increases in N_2O emissions. Hence, although there are regions where N_2O emissions can be reduced considerably, it is questionable whether these reductions can avoid a further increase in worldwide emissions.

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The National Space Grant College Program: A Resource for MTPE Educators and Researchers

— **Peter Mouginis-Mark** (pmm@kahana.pgd.hawaii.edu), Director, Hawaii Space Grant Consortium, University of Hawaii, Honolulu, Hawaii 96822

One of the key components of Mission to Planet Earth (MTPE) is the distribution of results to the broadest community segments, including schools, the general public, and local administrators. However, as research scientists, it is often difficult for us to find either the time to interact with these groups, or to know how to prepare materials in a form that conveys the excitement and relevance of our research to the non-specialist. While NASA's Office of Mission to Planet Earth (Code Y) education program provides a fine range of materials at the national level, it is often at the local level where help is needed most. One aspect of NASA that MTPE investigators may not have heard about is the National Space Grant College Program, which may be able to offer the type of local educational assistance that we need.

The National Space Grant College program is run by NASA's Education Division (Code FE). There are 52 individual national programs (a consortium in each state, plus D.C. and Puerto Rico), each with a director and an advisory board. Currently, there are over 550 different institutions involved in Space Grant, so that in many states the distance to your local Space Grant affiliate is quite small. Because of this national Space Grant network, it is possible for the MTPE investigators to contact local educators who have already established an extensive network of contacts in schools, colleges, and industry to provide educational outreach. These people are often experts at implementing educational programs, but frequently lack the current information on MTPE projects that is needed to excite students at all levels.

Space Grant's charter is to promote space science in the areas of research, education, and public service. This educational outreach is conducted at all levels, including K to 12, undergraduate, graduate, and the general public. A key component of each Space Grant consortium is the Undergraduate and Graduate Fellowship Program, which makes funds available to students who are U.S. citizens to develop research interests that are focused on space or aeronautics. Consortia in the different states have different areas of specialization that focus on local strengths and interests within the community. These topics include astronomy, aeronautics and space engineering, the development and launching of small payloads using sounding rockets, Earth remote sensing, and planetary exploration. Several Space Grant consortia have strong ties to MTPE, since their directors or key associate directors are also research scientists conducting remote sensing studies of the Earth. States involved include Hawaii, Colorado, Texas, North Dakota, New Hampshire, and California.

There are many areas where MTPE investigators and Space Grant might work productively together. In particular, providing educators with materials that show the value of long-time-series satellite observations of the climate, the application of remote sensing to land use characterization, or the mitigation of natural hazards, are topics where MTPE scientists could significantly help educators. In return, Space Grant has excellent contacts with local communities, including in many cases aerospace industries, and is adept at presenting materials at the appropriate level for different types of students. In addition, Space Grant provides a stream of talented and enthusiastic undergraduate and graduate research students who could prove essential as missions such as EOS start to return their data.

For more details of the national program, check out the following Web site: http://deimos.ucsd.edu/space_grant/NASAspacegrant.html. The most useful part of this Web site is the listing of all the individual consortia Home Pages and contact addresses. In addition, there is a description of the first five years (1989 - 1994) of the Space Grant program, and the National Space Grant Strategic Plan for 1996 - 2000. You are strongly encouraged to contact your local director to see if he/she can help you with any aspect of your outreach program.

Topographic Field Trip of Washington, D.C. on CD-ROM

— U. S. Department of the Interior, U. S. Geological Survey, Reston, VA 22092

A tour of the White House, a flight into Washington National Airport, and a view from the top of the Washington Monument are but a few of the activities found on a new educational CD-ROM now available from the U.S. Geological Survey. Designed as a teaching aid, this interactive CD-ROM, titled "Topographic Field Trip of Washington, D.C." contains an interactive tour of Washington, D.C., based on USGS topographic maps. Although targeted to middle school students, it can be used on Macintosh-based computer systems as an introductory teaching tool for topographic maps at many educational levels.

Students become "tourists" to the Nation's capital and use tools to: (1) measure distance and direction, (2) determine latitude and longitude, (3) learn map symbols, (4) look at aerial photographs, (5) determine elevation, (6) find "postcard" information, and (7) examine historical maps.

The Topographic Field Trip uses multimedia to navigate through layers of information linking sounds, graphics, text, and animation in a game-like adventure. The "Topographic Data Navigator" resembles a video game controller and functions as an interactive map legend.

After "landing at Washington National Airport" and exploring the topographic map, tourists will be required to answer questions in their journals. For example, "The green color on a topographic map represents__." These questions must be answered correctly to proceed with the tour. The four tour areas, the "Airport," "Arlington," "Downtown D.C.," and the "Mall," encompass the geographic area of the Topographic Field Trip. Correct responses earn rail farecards that are used to travel from one area to the next.

The tourists also use their journals to record information or observations that can be saved and later printed. The journal questions at each tour area highlight distinct components of topographic maps. When they have visited all of the tour areas and answered the journal questions correctly, tourists earn a ticket to visit the White House. If the field trip is not completed during one session, there is the option to return to the same area and continue at a later time.

This CD-ROM is designed for use on Macintosh-based computer systems only. The minimum system requirements to use the CD-ROM are as follows: Macintosh systems with 256-color, 13-inch or greater monitors; at least 8 Mb of RAM; System 7 or greater; and a Macintosh-compatible CD-ROM drive.

Because the "Topographic Field Trip of Washington, D.C.," was designed specifically for educators to use in a learning environment, please request single copies on school or organization letterhead. Requests should be sent to the U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225-2086.

For information about other USGS products, call 1-800-USA-MAPS, or access the USGS homepage on the World Wide Web at URL: http://www.usgs.gov/.

(Continued from Page 10)

CSR3.0 (Eanes-Bettadpur)
AG95 (KMS Andersen-Grenoble)
DW95.1 (CU Desai-Wahr)
FES95.2 (Grenoble Le Provost *et al.*)
ANTHA2 (CU Kantha)
ORI (U. Tokyo Matsumoto *et al.*)
GSFC (Sanchez-Pavliz)
RSC94 (GSFC Ray-Sanchez-Cartwright)
TPX0.2 (OSU Egbert *et al.*)
SR95.1 (Delft/GSFC Schrama-Ray)

PLEASE NOTE:
These models are of limited use outside of the research community. In shallow waters they are inaccurate, which makes them unsuitable for navigation or other practical applications. Please read the full description of this product before ordering.

JPL PO.DAAC data are free of charge. For further information contact: podaac@podaac.jpl.nasa.gov; or access URL: http://podaac.jpl.nasa.gov.

(Continued from page 17)

record and monitor the extent and surface conditions of the Earth's major ice masses, according to Long. Scientists are using the Antarctic image to understand the effects of the ice pack on the oceans and on related climate systems. The image shows variations in the ice sheet, as well as a "super-iceberg" that broke off the Thwaites ice tongue and is now circulating in the sea-ice pack.

"Spaceborne radar remote sensors are uniquely well-suited for mapping the polar regions since the radar can image the surface through clouds, both day and night. Similarly, radars also are useful for vegetation studies because different vegetation types and densities have different radar responses," Long said. "Tropical rainforests are critical to the climatic health of the Earth and are thought to contain half of all the world's species."

The new NSCAT image shows the extent of the tropical rainforest. The false color image is being used by scientists to identify types of vegetation on the surface, which allows them to differentiate between areas of tropical rainforest and regions of woodlands and savanna.

"This technique of using the scatterometer to study land and ice is a great new application of this radar instrument. We can get measurements of ice extent for use in research and as an aid to shipping, and we get them accurately and frequently under all weather conditions," said Jim Graf, the NSCAT Project Manger at the Jet Propulsion Laboratory (JPL), Pasadena, CA. "We can view large-scale vegetation changes enabling us to track the processes of desertification and deforestation. Data from the NSCAT instrument is extremely versatile and can be used to measure short-term changes over the oceans and long-term changes over the land and ice."

The scatterometer uses an array of stick-like antennas that radiate microwave pulses in the Ku-Band across broad regions of the Earth's surface. A small fraction of the energy in the radar pulses is reflected back and captured by NSCAT's antennas. At any given time NSCAT's array of six dual-beam antennas scans two swaths of ocean or land—one on either side of the satellite's near-polar, sun-synchronous 500-mile orbit. Each swath is 375 miles wide.

The scatterometer makes 30-mile resolution measurements of the wind over the oceans. This resolution is too coarse for most land and ice studies, but through computer enhancement of the data, Long is able to produce images with a virtual resolution of 4.8 miles or better. "This resolution is still coarse when compared with photographs, but it is nearly ideal for studying many land and ice processes," Long concluded.

The NSCAT instrument was launched on August 16, 1996, aboard Japan's Advanced Earth Observing Satellite (ADEOS). ADEOS is an international global change research mission of the National Space Development Agency of Japan, which includes instruments from the United States, Japan, and France, with investigators from many other countries.

JPL developed, built, and manages the NSCAT instrument for NASA's Office of Mission to Planet Earth, Washington, DC.

Images are available electronically through the Internet on the following URL: http://www.jpl.nasa.gov/winds/

1997 USRA/GSFC Graduate Student Summer Program in Earth System Science

The Universities Space Research Association, in collaboration with the Goddard Space Flight Center's Earth Sciences Directorate, is offering a limited number of graduate student research opportunities for the Summer of 1997. The Program is scheduled for June 9-August 15, 1997. It is open to students enrolled in or accepted to a U.S. accredited graduate program in the Earth, physical or biological sciences, mathematics, or engineering disciplines. Contact Roberta Harvey, Program Coordinator, at (301) 805-8396 or (301) 261-5095, Fax (301) 805-8466, or e-mail: rharvey@gvsp.usra.gov.

PCs In Space

— **Colleen Rapp**, cmrapp@hst.nasa.gov, EER

Tom Devlin (Jackson & Tull) in conjunction with several offices at NASA's Goddard Space Flight Center, has created interactive, kid-friendly space science software modules that are being distributed free of charge to students and teachers.

Conceived as a NASA community outreach project for Bowie State University Space Camp for Kids in Bowie, MD., Hubble Space Telescope mission simulation software was developed by Devlin to encourage student interest in the exciting world of space exploration. Since then, Devlin has sought the expertise of NASA scientists and engineers to review expansions to the software, and has now distributed six different modules, collectively called *PCs In Space*, to approximately 8,000 schools. More than 400,000 students around the country have explored this interactive software.

Elementary and middle school teachers face a scarcity of science curriculum aids. *PCs In Space* is a simple educational tool that helps fill that gap by combining the core science curriculum in a multi-disciplinary approach to reinforce other educational areas, such as math, history, geography, and vocabulary. For example, *Exploring the Solar System* lets kids use their math skills to see how much they weigh, how old they are, and how high they can jump on different planets. All of the modules are designed to teach children about computers while learning about the benefits of space exploration.

Using NASA graphical images, conversion programs, teacher and student surveys, and several test beds, Devlin developed educational software that would be easy for elementary school students to use. He selected Lab VIEW, a commercial, off-the-shelf platform that operates in the IBM and Macintosh environments, allowing him to spend more time on curriculum development as opposed to source code development. The multiplatform capabilities of the software also allowed Devlin to reach schools with wide ranges of computer platforms.

Devlin developed the software to show how NASA's technology benefits the public. Using data from NASA Projects such as Hubble Space Telescope and Landsat, Devlin's computer modules tie into existing curricula to teach children about space science. "Hopefully, it will inspire kids to think about careers in science or engineering," says Devlin.

In April, Devlin and another Jackson & Tull engineer, Ulysses Manley, were presented a Community Service Award by Joseph Rothenberg, the Director of Goddard Space Flight Center in Greenbelt, Md. They were recognized for their efforts to educate the public on the benefits of the space program and for inspiring children to pursue science and technology careers.

To date, universities from 27 states and the District of Columbia have signed distribution agreements for the free software. Under these agreements, the schools can distribute the software for educational purposes, but are not allowed to sell it. They receive upgrades with the latest images and discoveries. Universities from the remaining 23 states are reviewing the software.

To reduce distrubution costs, Devlin has established a Web site to provide on-line capabilities: http://www.gsfc.nasa.gov. Click on Education Programs and then click on *PCs In Space*.

Science Calendar

February 25-27	EOS Investigators Working Group Meeting, San Diego, CA. Contact Mary Hurlbut, tel. (301) 220-1701; Fax: (301) 220-1704; e-mail: mhurlbut@pop200.gsfc.nasa.gov.
March 4-6	AIRS Science Team Meeting, Santa Barbara. Contact George Aumann, tel. (818) 354-6865; e-mail: hha@airs1.jpl.nasa.gov.
March 11-13	EOS ATBD Review: PM-1, ACRIM, SAGE-III and DAO, NASA/Goddard Space Flight Center, Greenbelt, MD. Contact: Doug Bennett, tel. (301) 286-7370; e-mail: dbennett@pop900.gsfc.nasa.gov.
March 14	AMSR Science Team Meeting, NASA/Goddard Space Flight Center. Contact E. Lobl, e-mail: elena.lobl@msfc.nasa.gov.
April 15-17	Landsat Science Team Meeting, Valley Forge, PA. Contact Sharland Norris, tel. (301) 220-1701; e-mail: sharland@ltpmail.gsfc.nasa.gov.
April 18-21	CERES Science Team Meeting, NASA/Langley Research Center. Contact Gary Gibson, e-mail: g.g.gibson@larc.nasa.gov.
April TBD	Land Processes DAAC Meeting. Contact Bryan Bailey, e-mail: G.=Bryan=Bailey%ssb%EDC@edcserver1.cr.usgs.gov.
May 13-16	MODIS Science Team Meeting, NASA Goddard Space Flight Center. Contact Barbara Conboy, tel. (301) 286-5411; e-mail: barbara.conboy@gsfc.nasa.gov.
June 11-13	TES Science Team Meeting, Harvard University. Contact Reinhard Beer, e-mail: beer@caesar.jpl.nasa.gov.

Global Change Calendar

January 26-30	Space Technology and Applications International Forum, Albuquerque, NM. Contact Professor Mohamel S. ElGenk, tel. (505) 277-2813/0446/4950; Fax: (505) 277-2814/5433.
February 3-6	AMS 77th Annual Meeting, Long Beach, California. Long Beach Convention Center. Contact Monica Tolson, tel. (202) 682-9006.
February 13-18	AAAS Annual Meeting and Science Innovation Exposition, Seattle, WA. Contact Dee Valencia, tel. (202) 326-6417; Fax: (202) 842-1065.
March 10-14	Atmospheric Effects of Aviation Annual Conference, Virginia Beach, VA. Contact Julie Catloth, tel. (301)286-7912; e-mail: catloth@polska.gsfc.nasa.gov.
March 24-27	Second International Symposium on the Expansion of the Remote Sensing Market, Paris. Contact Céline Douchez, tel. 33 (1) 47 23 58 11, Fax 33 (1) 47 23 89 11.
April 1-5	Association of American Geographers, Ft. Worth, TX. Contact Kevin Fitzpatrick, tel. (202) 23401450; Fax (202) 234-2744; e-mail: kfitzpat@aag.org.
April 7-9	ACSM-ASPRS Annual Convention and Exposition, Seattle, WA. Contact Nadine Derowitsch, tel. (301) 530-1619; Fax (301) 571-1988.
May 27-30	American Geophysical Union, Baltimore, MD. Contact AGU Meetings Dept., tel. (202) 462-6900, WWW URL: http://www.agu.org.
June 12-13	The International Climate Change Conference and Technologies Exhibition, Baltimore, MD. Call for Papers. Contact Exhibition office, tel. (301) 695-3762; Fax (301) 295-0175.
July 7-10	Third International Airborne Remote Sensing Conference, Copenhagen, Denmark. Contact ERIM/Airborne Conference, P.O. Box 134001, Ann Arbor, MI 48113-4001, tel. (313) 994-1200, ext. 3234; Fax: (313) 994-5123; e-mail: wallman@erim.org.; WWW URL: http://www.erim.org/CONF/conf.html.
August 4-8	1997 International Geoscience and Remote Sensing Symposium, Singapore. Contact IEEE/GRSS, 2610 Lakeway Drive, Seabrook, TX 77586, tel. (713) 291-9222; Fax: (713) 291-9224; e-mail: tstein@phoenix.net.
October 13-16	First International Conference on Earth Observation and Environmental Information, Alexandria, Egypt. Call for Papers - titles and abstracts due May 1, 1997, on the following research themes: oceans and coastal processes; water resources; land use/land cover. Contact Bashir Saleh, P. O. Box 1029, Miami, Alexandria, Egypt, tel. 011 (203) 5602578, or 5601785; Fax: 011 (203) 5602915; e-mail: ruaafeng@rusys.EG.net; WWW URL: http://www.frcu.eun.eg/www/conference/aast.html, and http://www.ceosr.gmu.edu/news.html.

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